Published, with minor revisions, in **Transportation Research Record 1848**, (Transportation Research Board, National Research Council, Washington, DC, 2003), pp. 70-78.

RESOLVING THE CONFLICT BETWEEN MOBILITY-IMPAIRED PASSENGER REQUIREMENTS AND FREIGHT SERVICE ON MIXED HIGH AND LOW PLATFORM U.S. RAILROAD LINES

By Edward K. Morlok
UPS Foundation Professor of Transportation, and Professor of Systems Engineering, University of Pennsylvania*

Abstract

One objective of this paper is to explain the conflict that has emerged and is growing between (1) requirements for passengers on wheelchairs and other mobility-impaired travelers for accessibility onto passenger trains, and (2) requirements for general freight service on the same tracks on certain types of railroad lines. The second objective is to present two designs for entranceways for railroad passenger cars that seem to resolve this problem, and also have additional benefits. This conflict emerges where high level platforms are used (at stations) on tracks that are also used by freight trains, because such platforms intrude into the normal clearance envelope of freight trains. High level platforms are now most commonly used in the Northeastern U.S., but more extensive use elsewhere is contemplated because of various benefits for passenger service. After presenting the problem, this paper reviews prior evaluations of various generic approaches to providing platform to train access —in foreign railways and in rail transit contexts – to identify characteristics of effective ADA-compliant solutions. Then two related new approaches designed for North American railroad conditions are presented. It is hoped that this paper will encourage research into this problem and the testing and ultimately the deployment of technologies that will provide effective transport for mobility-impaired travelers on the railroads while maintaining characteristics necessary for freight service.

Keywords: Railroads, ADA, high level platforms, low level platforms, rail freight and passenger service conflicts, passenger cars.

November 2002
Presented at the 2003 Annual Meeting of the Transportation Research Board
Washington, DC, January 2003

* Electrical and Systems Engineering Dept.
University of Pennsylvania
220 S. 33rd St. – 229B Towne Bldg.
Philadelphia, PA 19104-6315

Tel: 215.898.8346
Fax: 215.898.5020
Email: morlok@seas.upenn.edu
Website: http://www.seas.upenn.edu/sys/homemorlok.html

INTRODUCTION

This paper has three objectives. One is to document the growing conflict between current methods to meet ADA accessibility requirements on certain types of railroad lines and the provision of freight service on those lines. The second is to encourage research on means to resolve this conflict. The final objective is to present two related approaches for resolving the conflict.

There is a basic conflict between high level (HL) platforms for passenger service and the provision of general freight service on the same tracks on U.S. (and other North American) railroad lines. The reason is that HL platforms intrude into the normal clearance envelope of a rail line. Depending on the circumstances, this intrusion either completely precludes passage of some freight cars and their cargo loads, or makes such passage unsafe. It also interferes with other important rail freight activities. The problem is becoming acute because new HL platforms are being planned and installed on virtually all rail lines that have a combination of high and low platforms now. Furthermore, many plans for improved existing or new rail passenger services — including both intercity and commuter service — envision use of HL platforms. A primary driving force behind these plans is meeting the universal access requirements of the Americans with Disabilities Act (1). Partly because of features of rail car design, passengers on wheelchairs and other mobility-impaired travelers are accommodated on mixed platform railroad lines at HL platforms only. In addition, current methods for accommodating mobility-impaired travelers on these lines have many deficiencies for these passengers and passenger service operators.

The plan of the paper is as follows. First, the basic conflict between HL platforms and freight service is described. This is followed by a review of the relevant requirements of the Americans with Disability Act (ADA). Then conclusions of prior evaluations of different approaches to meeting ADA accessibility requirements are briefly presented, as these provided very useful guidance for solutions. Finally two related approaches to resolving the conflict through design features of railroad passenger cars are presented. One design is for cars of the end vestibule type commonly used now on lines having both HL and LL platforms (and elsewhere). The other is intended for new cars, which with an optional modified LL platform, provides essentially automated accommodation of mobility-impaired passengers at all types of platforms.

INCOMPATIBILITY BETWEEN FREIGHT SERVICE AND HL PLATFORMS

For those not familiar with the various types of railroad station platforms, Figure 1 presents the basic types. Figure 1(a) shows a high level (HL) platform, which is approximately level with the floor of a traditional railroad car. Figure 1(b) shows the more common low level (LL) platform, and the stairs in the end vestibule (entranceway) of a typical car. Figure 1(c) shows a set-back HL platform, which provides greater clearance for wide cars (and cargo loads) than a standard HL platform but has a larger car to platform gap.

The source of the incompatibility between HL platforms and freight service is shown in Figure 2, which superimposes HL and LL platforms onto a diagram showing normal railroad clearances and a car exterior envelope (based on information in (2,3)). The fact that a HL platform intrudes substantially into the normally clear area around a track is evident from this figure. The consequences of this for rail freight service are very serious, as described below.

Safe Passage of Cars and Locomotives

One problem is that many if not most freight car bodies are wider than passenger car bodies, and will not safely pass HL platforms given the normal variations in the relative location of track and platforms. Passenger cars for HL platform operation are typically 10 ft 0 in (3048 mm) wide at the floor level, while many common types of freight car are 10 ft 6 in to 10 ft 8 in (3200.4 to 3251.2 mm) wide. 10 ft 8 in is the maximum width permitted for unrestricted interchange among railroads (AAR Equipment Plate B, in (3)). A moving car will roll from side to side, and thus even though a full-width car should clear a HL platform by 3 in (76.2 mm), the car body or a door may strike the platform. Particularly troublesome are cars with side doors, which are sometimes open during movement (partly for safety reasons related to persons becoming trapped inside). Furthermore, in practice the relative location of track and platform can not be maintained exactly, given weather variations, frost heaving, maintenance of track, etc. (Data on actual gaps are presented later in the ADA section). For these reasons, when freight and passenger service was operated by the same railroad company, HL platforms were simply not placed on lines where they could present a safety hazard or interfere with freight service.

Switching Operations

A second problem is that during switching operations, it is usually necessary for train crewmembers to ride on the outside of cars while they are being moved. HL platforms obstruct the area where the crewmember must be, and thus present a lethal hazard.

Excess Dimension Loads

Further exacerbating the problem is that many rail lines have been improved over many decades so that they can accommodate *excess dimension loads*. These loads are wider (and/or higher) than freight cars, but can be accommodated if the normal clearance standards are adhered to in tunnels, bridges, etc. Introduction of HL platforms would destroy this asset (in the horizontal dimension) of these lines. Accommodating excess dimension loads is sufficiently important for regional economies that some states (e.g., Pennsylvania) share financing such upgrading of lines.

Conclusion

HL platforms on rail lines interfere with the provision of normal freight service. Even if all existing trains on a line will clear HL platforms, the introduction of such platforms will preclude carrying other shipments that use larger cars and excess dimension loads in the future. This diminishes the value of the rail line, to the freight railroad, industry and freight service users, and more broadly to the region--since industrial development options are curtailed.

INCOMPATIBILITY NOT NEW

It is important to note that this incompatibility between HL platforms and freight service is not a new development. Past editions of the *Locomotive Cyclopedia* show many freight locomotives that were too wide to pass a HL platform (e.g., from 1922, one that would strike a HL platform (4), p.168)). This is yet another reason why railroads have long opposed the introduction of HL platforms on most lines.

In the past, HL platforms were limited to a few passenger stations and nearby trackage where no freight service was operated, or where limited service occurred with locomotive and car width being carefully controlled. Examples include Grand Central Terminal and Pennsylvania Station in New York. In some cases tracks bypassing high platforms were built for freight service, such as the "High Line" around the main intercity station in Philadelphia. Gantlet tracks, which have rails parallel to other rails that shift a train sideways about a foot (304.8 mm) or more, also have been used to provide needed clearance for trains of different widths.

Some passenger lines have had HL platforms exclusively, with separate parallel tracks provided for freight. An example is the Chicago-area Metropolitan Rail (METRA) Electric Division commuter line, which was constructed (by the Illinois Central Railroad) with four additional separate tracks for freight and other passenger trains.

A few passenger stations have some tracks with HL platforms and others with LL platforms. These are mainly where differences between passenger cars require both. An example is Washington Union Terminal. There Amtrak's Acela trains require HL platforms, while some Virginia Railway Express (VRE) commuter trains and Amtrak long distance trains with hi-level cars require LL platforms.

ACCOMMODATING MOBILITY-IMPAIRED PASSENGERS

The aspect of accommodating mobility impaired travelers that relates to station platforms – and hence freight service – is the provision for travelers to pass between the platform and the train. The Americans with Disabilities Act (ADA) (1) specifies the maximum gap that can exist between the train and platform at the door, and other features of the entranceway. Naturally there are other requirements, both on the train and in the station, but these do not concern us here.

Differences Due to Platform and Car Type

The means of access to trains depends on the design of both the car and the platform. There are three types of lines that distinguish different conditions:

1. The train stops at HL platforms exclusively.
2. The train stops at both HL and LL platforms.
3. The train stops at LL platforms exclusively.

There are few Type 1 lines at the present time. These include the previously mentioned METRA line, and various lines in the Northeastern U. S. that are used primarily for commuter or intercity passenger trains. Most of these have no freight service, or limited service, unless separate (or gantlet) tracks are provided.

Type 2 is very common, because of a few main stations that are equipped with HL platforms, including major stations in Philadelphia, New York, Boston, and Montreal, among many other cities. Also, as mentioned earlier, passenger agencies are replacing LL platforms at many stations with HL ones.

Type 3 is currently the situation in the west and south, but proposals to introduce new or improved service often include introducing HL platforms, which convert these lines to Type 1 or Type 2. Current car designs for LL platforms only accommodate mobility-impaired travelers with a portable ramp or other device that does not obstruct freight clearances. Thus this situation does not directly concern us, although one of the designs presented later can be used with LL platform only systems as well.

Lines of Type 2 are the primary concern, because Type 3 presents no problem for freight service, and Type 1 lines avoid the conflict by virtue of little or no freight service. However, the new designs presented later would apply to Type 1 if new or expanded freight service were envisioned (as is being discussed for the I-95 or Northeast Corridor, for example). First, however, the characteristics of HL platform access for mobility-impaired travelers must be reviewed.

Problems with HL Platforms for Mobility-Impaired Access to Trains

On lines where a train must stop at both HL platforms and LL platforms, the car design used (in the U.S., and generally elsewhere) has the traditional end vestibule. This consists of steps from the car floor level to a LL platform, a trap door to cover the steps when access to a HL platform is needed, and an outside door.

Platform to Train Gaps

With this design access to trains by mobility-impaired passengers is necessarily from a floor-level platform, i.e., HL platform. Ideally the platform and car trap door floor would form a level surface (resulting in no vertical gap) and the horizontal gap between them would be small, as in the case of an elevator, for example. However, railroad industry standards and requirements for cars and platforms preclude such an ideal situation. Reference to Figure 2 may assist in following this discussion.

Industry standards require that the horizontal gap be at least as great as the maximum gap allowed by ADA (for new cars)—3 in. (76.2 mm). In fact it is much larger, partly due to general design features of both older and new cars, and partly due to the (already mentioned) variations in the relative location of tracks and platforms. Similarly, by design the vertical gap exceeds the maximum permitted by ADA of 1.5 in (38.1 mm) (at existing stations). To put these into perspective, the range of actual gap dimensions from an unpublished survey of intercity and commuter stations in the Philadelphia area were: horizontal, 5 to 10 in (127.0-254.0 mm), and vertical, 4 to 10 in (101.6-203.2 mm). The ADA requirements simply can not be met with HL platforms only.

Manual Bridge Plate and Train Delays

The result of this unavoidable nonconformance to ADA is that to accommodate mobility-impaired passengers a bridge plate must be placed over the gap at HL platforms. In the U.S., these are normally kept at the station. A member of the train crew unlocks the plate holder at the station, carries the bridge plate to the entranceway, positions it, and then the traveler can enter (or leave) the train. The plate is then moved back to the holder and locked into position. Usually a plate is located at each end of a station, but due to vandalism, sometimes the only plate available is at the far end of the station platform, requiring a long walk by the crewmember. No formal studies of the time required for this process have been found for U.S. stations. However, in Europe a similar process is widely used, for there the gaps at HL platforms are generally not compatible with wheelchairs either, and the reported typical delay times are from 3 to 5 min (5). If space permits, plates could be carried on trains, probably reducing the delay.

It should be noted that on lines of Type 1, where cars are designed for HL platforms only, the same problem with nonconforming vertical and horizontal gaps applies. Bridge plates must be used there as well.

Added Cost of HL Platforms

At stations with LL platforms, access for mobility-impaired passengers is problematic. One approach is to replace the low platforms with HL ones. This is expensive. Recent costs for commuter lines, with two platforms per station (one along each track) range from an estimate per station averaging about $1.4 million (6) to budgeted amounts for platforms being rebuilt of $6.5 million (7). Cost alone precludes—or at least slows the pace of--converting many stations. Most Northeastern commuter agencies are rebuilding some stations, or building new ones, with LL platforms, even though HL platforms exist elsewhere on the same line.

Mini HL Platforms

At such LL platform stations, wheelchair access is usually provided by a mini HL platform. This is a short platform, about 20 ft (6096.0 mm) in length, reached from the main platform via a ramp for mobility-impaired passengers. One disadvantage of this approach is that often trains make two stops, one at each platform, although in principle the normal stopping location could be shifted to avoid this.

Set-back Mini HL Variation

Many mini-HL platforms are set back from the usual location—about 1 to 2 ft (304.8-609.6 mm) so as to provide the clearance necessary for freight trains. The resulting large gap necessitates use of a bridge plate, of course. For example, the major freight railroad Conrail permitted mini-HL platforms located 7 ft 6 in (2286.0 mm) from the track centerline on some lines. Such a *set-*

back HL platform provides an acceptable clearance for some freight service, though not adequate in all situations.

Other Platform-Based Approaches

Three other platform-based approaches are used. One consists of a retractable HL platform in which the edge near the track rotates up and out of the way of freight trains. Another is a sacrificial edge to the HL platform, which is designed to break off if struck by a train, and be easily replaced. Both are likely to be costly even if used widely, and safety is clearly an issue too, for both passengers and trains. A third approach is to provide an on-platform lift. This is not widely used in the U.S., probably because of the cost and difficulty of maintaining the lift in working order (and perhaps reports of negative experience from Europe, briefly reviewed below).

Conclusion

The current method for accommodating mobility-impaired passengers, using HL platforms and a manual bridge plate, has many shortcomings. It is expensive, demeaning to mobility-impaired passengers because of the special treatment required and the delays to trains, and not feasible at many locations because of its incompatibility with much freight service.

PROBLEM LIKELY TO GROW

This conflict is very serious now, and is likely to become more serious in the future, for two reasons. The Americans with Disabilities Act (1) requires that mobility-impaired travelers be accommodated on all rail passenger lines. Given the choice of HL platforms as the primary—almost exclusive—means to meet this requirement in a mixed LL and HL platform environment, some type of HL platform is envisioned at virtually all stations.

The second reason is that HL platforms are envisioned for many new or improved passenger services. Many regional and commuter lines prefer HL platforms, entirely apart from ADA considerations. The advantages seen include speeding up service through shorter dwell times at stations and the opportunity to reduce crew sizes as a result of switching to remotely controlled doors—a feature that on most cars applies only to high platforms. Also, most proposals for high speed rail envision HL platforms only.

Thus the number of HL platforms is increasing substantially, and is likely to continue to increase if current passenger agency plans are carried out. Thus the severity of the conflict with freight service will almost surely grow.

GUIDANCE FROM PRIOR STUDIES

Previous studies by others have identified and evaluated various approaches to accommodating mobility-impaired passengers on rail systems that have a mixture of platform heights relative to car floors. This situation is common in Europe, with a vast variety of platform heights, even in the same country, and some variation in car floor heights. A comprehensive study of these supported by the European Commission is presented by Dejeammes (5). Since the range of alternatives considered and conclusions reached are similar to other studies in Europe and North America, results of this study will be briefly reviewed. The approaches considered included:

1. platform ramps, which are moved into position for each use,
2. platform lifts (powered),
3. ramps carried onboard the train, and
4. lifts built into the rail car (powered, in the end vestibule).

Each of these approaches was evaluated, and the data indicated various advantages and disadvantages for each. Almost all had serious disadvantages, including: substantial time required to deploy the device, difficulties in maintaining it in operating condition, and the need for pre-booking of travelers in order to ensure that personnel to operate the device are available for the train being taken, among others. For example, platform lifts were reported to typically take 2 to 5 min to operate.

It was concluded that "[t]he aim for total accessibility to trains for all passengers can only be achieved by means of level or step-free access to all facilities from the platform and within the trains." (5, p.53). Two related specific means to achieve this goal were recommended:

1. use of a bridging plate or access ramp (on the car) that automatically fills the gap at a station stop;
2. raising the platform on a limited area to provide level entry – a recommendation for consideration since it was not used in Europe at the time.

Interestingly, the overall approach being recommended is similar to but goes beyond that being followed in North America. Clearly the second recommendation is the mini HL platform concept. This specific approach is being used now, but has limitations due to interference with freight service. However, other means for achieving a step-free entry are possible. The other recommendation – having the bridge plate automatically deployed – is important. The overall goal of an automatically deployed step-free entry for mobility-impaired travelers guided the concepts to be presented below.

SOLUTIONS FOR NORTH AMERICA

Returning to the problem in North America, there are two basic approaches that will resolve the incompatibility problem and simultaneously accommodate mobility-impaired passengers in an effective way.

- One is to modify car entranceways so that they provide an automatically deployed bridge plate for both standard location HL platforms and set-back HL platforms. This then overcomes the difficulties in situations where the set-back platform provides clearance that is adequate for freight service.
- The other is to modify car design so that mobility-impaired passengers are accommodated at LL platforms.

Designs for these two approaches are described in the two major sections below.

DESIGN 1: ENTRANCEWAY MAKING HL PLATFORMS ACCESSIBLE

This design is intended to be used where the line has LL and HL platforms, and ADA access is to be provided from standard location HL and set-back HL platforms (presumably at LL platform stations) only.

Design and Operation

Essential features of the design are illustrated in Figure 3. 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 3(a) shows the block in position for a LL platform. Both doors are powered and controlled remotely, and open for LL platform use.

Figure 3(b) shows the trap-step-block in position for a HL platform. When the train arrives at a HL platform, the powered bridge plate (normally vertical against the door) is rotated (about axis B-B, by remote control), so that it rests on the HL platform. It thus provides a smooth ramp between the car floor and the platform, bridging the gap. Simultaneously the entranceway railing on each side of the bridge plate would descend. Then the HL doors are opened. Once all passengers have passed, the door is closed, the bridge plate and railing are raised, and the train can depart.

The bridge plate is designed to completely cover any gap at a standard or set-back HL platform. Also, mobility-impaired passengers are accommodated without the need for a crewmember to manually place a standard bridge plate at the entranceway.

Features

An important feature of this new design is its compatibility with both new car designs and older, existing cars. It would also be advantageous to replace the trap-step-door assemblies of existing traditional vestibule cars with this new design, and the design is intended for such retrofitting. (In fact, most intercity cars with end vestibules now have rotating step blocks for the two or three lower steps, that rotate the steps almost 90 degrees to provide a streamlined exterior and conform to clearance requirements.) This design can be used for different entranceway locations (center of body, quarter points, or ends) and number of passenger lanes per entranceway.

Details on the design, and numerous variations, are provided in (8) including information on the transition between HL and LL platform configurations, and the reasons for use of a rotating block instead of alternatives such as sliding (vertically or horizontally) steps. The step-trap-block area is completely closed off during transition by doors—essential for passenger safety. (This is similar to the securing of the vestibule area on VRE cars when the powered traps are raised and lowered remotely.). Other advantages such as reducing dwell times at stations, crew cost savings, and reduced injuries to passengers and employees are presented in (9).

While compatible with both HL and LL platforms, this entranceway provides ADA access at only at HL platforms (full length or mini in the standard location, or mini platforms set-back as described earlier). Since only some rail lines can accept these, given the infringement on freight clearances, an alternative design for mobility-impaired passenger access at LL platforms is also needed.

DESIGN 2: CAR BODY AND ENTRANCEWAY MAKING HL AND LL PLATFORMS ACCESSIBLE

The basic car and entranceway design for meeting ADA requirements at both HL and LL platforms is presented in Figure 4(a). The car body has a split-level configuration, consisting of a lowered center section (level 1) and two end sections (level 2) with floors at the usual car floor height of a single level car. The level 1 floor is about 17 in. (431.8 mm) above the rail, and thus one step above the standard location for a LL platform. One or more HL doors are provided on level 2, for HL platforms. Similarly level 1 has one or more LL doors for LL platforms. To enable passengers to move freely between levels 1 and 2, stairways are provided at each end of the car. For mobility-impaired passengers, one or more lifts are provided. Figure 4(b) shows the lift located between the two sets of doors, so that mobility-impaired passengers have access to both HL and LL platform doors and both levels. Where the doors are not adjacent to the lift, aisles must be sufficiently wide for wheelchairs. Figure 4(c) presents cross sectional views further illustrating the two floor levels. Details are provided in (10).

HL Platform Operation

The HL doors are equipped with a powered bridge plate, that is deployed by remote control by either a crewmember or a passenger. Functionally it is similar to the bridge plate in Design 1, but because it is affixed to the car side many design variations can be used. These include rotating and extending plates (the latter on many light rail vehicles, e.g., detailed in 11). This effectively provides for ADA-compliant access at all types of HL platforms.

Standard LL Platform Operation

At LL platforms the level 1 LL doors are used. To enable mobility-impaired passengers to board and alight at standard LL platforms, either of the two usual approaches (used in the U.S. and Canada) can be employed. Where the station platform is sufficiently wide, a long moveable ramp can be manually attached to the car floor at the door, the other end resting on the platform. The modest slope then enables wheelchair passage between the floor and platform. The ramp might be carried on the car, or be located at the station. Where the platform width is insufficient, then a lift of the type used by Amtrak and others on bi-level (double deck and gallery) cars could be used. This is installed on the train. However, superior to both the ramp and lift is the new type of LL platform described below.

AN IMPROVED LL PLATFORM AND ENTRANCEWAY DESIGN

Clearly it is desirable to eliminate the manual ramp placement for mobility-impaired passengers. This can be achieved by a modification to the platform design and a corresponding addition to the entranceway. These two related designs are shown in Figure 5. The LL platform is raised one step (about 8 in, or 203.2 mm) at a point about 6 ft 8 in (2133.6 mm), from the centerline of the track. This raised platform--called a *terrace platform* (to distinguish it from the short wooden "step-up platform" now used by some Northeast railroads) – is located in the triangular area shown in Figure 2, so that it satisfies railroad clearance requirements. It is reached via a ramp or ramps from the standard height LL platform, providing access for mobility-impaired travelers from that platform, the station, etc.

The level 1 entranceway is then equipped with a powered bridge plate that spans this gap between the car and terrace platform (about 2 ft. (609.6 mm) long). The similarity to the previously described design for HL platforms is clear, and the operational sequence with the doors is identical. Naturally this bridge plate would also be equipped with railings. If it is desirable for the normal height portion of the LL platform to be wider than the 1 ft. 11 in. (584.2 mm) of this design, then the terrace platform could easily be set back further. (Clearly a uniform standard for terrace platform location is desirable.)

The terrace platform--a functional substitute for the mini HL or HL platform--can be short, for only one entranceway or car, or installed for the entire length of the platform. In either case, the platform remains entirely compatible with all entranceways designed for use with LL platforms, since the track side portion is in the standard position. The trackside edge of the terrace platform is marked by stanchions, so that pedestrians are aware of the step. While the trackside edge could be a source of injuries, the widespread expansion of use of step-up platforms on mixed HL and LL lines—with steps on three sides --suggests that the accident experience has been satisfactory.

The bridge plate can be installed only on those cars that are to be used by mobility-impaired passengers, or on all cars—yielding flexibility in equipment assignments. This also creates the option of eliminating the LL platform next to the track, replacing it with the terrace level platform for all passengers. This has obvious safety advantages, by virtue of keeping passengers and others away from the track.

It is interesting to note that the Portland light rail system elected to introduce low floor cars in order to better meet ADA requirements, with a center section similar to level 1 of Design 2. An automatically deployed bridge plate is used (11), though with a smaller gap than possible on railroad lines. Similar arrangements are used on other light rail lines. Thus the choices of these systems lends support to the efficacy of the approach suggested here.

Eliminating the Need for and Advantages of HL Platforms (over LL Platforms)

This car's entranceway design, with or without the terrace LL platform feature, eliminates most if not all of the advantages of installing new HL platforms, and thus eliminates the source of the conflict between freight service and passenger service needs on the same rail line. The three primary reasons for using HL platforms are:

1. speeding passenger boarding and alighting,
2. enabling use of remotely controlled doors (so that even a small train crew can open and close all doors at every station), and
3. making rail travel accessible to mobility-impaired riders.

The LL doors are only one step above a (standard location) LL platform, and thus entry and exit at such a door should be almost as rapid—if not equally rapid--as that with level entry and exit.

All LL doors are remotely controlled. And LL platform access meeting ADA requirements is provided. Thus all reasons for using HL platforms from a passenger service perspective are addressed.

Related New Car Body Design to Offset Loss of Seating Area

The only disadvantage of this car and entranceway design is that it requires distinct doors for HL and LL platforms, reducing the space available in the car for seats (or standees)—at least in some body designs. The loss differs between single level and multiple deck cars, and examples of each will be considered.

Turning first to the most common double-deck car — the UTDC/Bombardier design, it has the same double width LL doors as this car. The main differences are the additions of the HL doors and wheelchair lift. Since that car has a wide aisle on level 2, the wall area of which can be used for the HL doors, the loss of seats would be small — 6 or less out of 144 seats (MetroLink version).

The seating loss on single level cars will be estimated for a commuter design with 2+2 seating. Similar relative comparisons would result from the larger pitch of intercity seating, or narrower 3+2 seats. Each door lane takes approximately the same length along the car as a row of seats. Most recently purchased single level commuter cars for both LL and HL boarding have single-lane end vestibules (LL and HL) and a single 2-lane center HL door, yielding 2 lanes for LL platforms and 4 for HL platforms. This allows about 25 rows of seats, with the typical 33 in (838.2 mm) seat pitch. This yields 97 seats, including one passenger in a wheelchair. Design 2 requires two double-width HL doors and one double width LL door to provide equivalent door lanes. Such a car would seat 89, an 8.2% reduction. While the reduction is small, it would mean an increase in fleet size of 9.0% to yield the same seating capacity, a clear disadvantage.

Many single level cars are used where overhead clearances do not permit a standard double-deck car. These restrictions occur in the New York and Philadelphia areas, for example. To overcome the disadvantage of seat loss, a double-deck car body design was developed that provides normal ceiling height over aisles while meeting these restrictive clearances (described in detail in (12)). This design, with two 2-lane doors for each level, can seat 130 passengers (including 2 in wheelchairs), 34% more than the base single level car. Thus the disadvantage of loss of usable car space in order to provide more effective access for mobility-impaired passenger at LL and HL platforms can be overcome.

CONCLUSIONS

Evidence has been presented that the conflict between the needs of freight service and passenger service is serious and is likely to grow in the future. While primarily a problem in the Northeastern part of the U.S. now, it exists elsewhere and is likely to spread. To resolve it requires research into ways of meeting the requirements of ADA accessibility in passenger service while maintaining the clearances required for freight service. Since both car design and station platform design create the conflict, solutions may be sought in advances in one or the other, or both.

Two rail car entranceway designs have been presented that may help resolve the conflict. Design 1 is intended for railroad lines where set-back mini-HL platforms provide adequate clearance for freight service. Design 2 is for new cars, and is intended to avoid the need for HL platforms wherever they would limit freight service or have other disadvantages (compared to LL platforms). Furthermore, these designs reduce or eliminate the extra tasks (performed by train crews) and increased stop time necessary to accommodate mobility-impaired passengers, thereby helping to bring these riders into the mainstream of rail passengers.

Finally, it is hoped that the paper will encourage efforts to resolve this conflict and to deploy technologies that will provide satisfactory rail service to all.

ACKNOWLEDGEMENTS

Awareness of this problem emerged in the course of freight research supported by Conrail, USDOT, NSF and others. Helpful discussions with many persons too numerous to list, primarily in passenger and freight railroads, and the support of both USDOT (through MAUTC) and the UPS Foundation, are gratefully acknowledged.

REFERENCES

1. Americans with Disabilities Act, *ADA Accessibility Guidelines* (ADAAG) 2001. Sec.10 Transportation Facilities. 2001. http://www.acess-board.gov/adaag/html/adaag2.htm, pp. 15-20. Accessed May 18, 2001.

2. American Railway Engineering and Maintenance-of-Way Association, *Manual for Railway Engineering*, 4 vols. AREMA, Washington, D. C., 2002.

3. Kratville, William W., Editor, *The Car and Locomotive Cyclopedia*, 6th Editon, Simmons-Boardman Books, Inc., Omaha, Nebraska, 1997.

4. Wright, R. V., Editor. *1922 Locomotive Cyclopedia of American Practice*, 9th Ed., Simmons-Boardman Publ. Co., New York, 1922.

5. Dejeammes, M. Boarding Aid Devices for Disabled Passengers on Heavy Rail: Evaluation of Accessibility, *Transportation Research Record 1713*, 2000, pp. 48-55. Full EU report can be accessed via http://www.cordis.lu/cost-transport/src/cost-355.htm (accessed 7/24/02).

6. SYSTRA Consulting, Inc. *Regional Rail Improvement Study R5 Lansdale/Doylestown Line*. Final Report to Delaware Valley Regional Planning Commission, January 2002, Appendix, p.5.

7. New Jersey Transit, Capital Improvement Program>Hazlet Station High-Level Platform Project, www.njtransit.com/an_capitalprojects_project027.shtm, also others in same series, accessed 30 Nov. 2001.

8. Morlok, Edward K., *EBD 1.1: A New Railroad Commuter Car Entranceway Design for Mixed High and LL Platforms.* Systems Engineering Dept. Working Paper, University of Pennsylvania, Philadelphia, PA, 2002. Available at: http://www.seas.upenn.edu/sys/morlokpage/rsdproject.html.

9. Morlok, Edward K., The Need for a New Commuter Car Entranceway Design for Mixed High and LL Platforms, Paper No. 02-2289, forthcoming in *Transportation Research Record*.

10. Morlok, E. K., Entranceway and Car Body Design EBD 2.1 – An Integrated Railcar Design for Mixed HL (Including Mini-HL) and LL Platform Lines that Meets Both ADA Accessibility Requirements and Freight Service Clearance Requirements, Systems Engineering Dept. Working Paper, University of Pennsylvania, Philadelphia, PA, May 2002. Available at: http://www.seas.upenn.edu/sys/morlokpage/rsdproject.html.

11. Porter D. L., Introduction of Low-Floor Light Rail Vehicles to North America, *Seventh National Conference on Light Rail Transit,* Vol .1, TRB, 1995, pp. 175-183.

12. Morlok, E. K., Entranceway and Car Body Design EBD 3.1 – An Three-Level (Double-Deck) Railroad Car Body with Full Height Aisles That Conforms to Northeastern Clearances, Systems Engineering Dept. Working Paper, University of Pennsylvania, Philadelphia, PA, May 2002. Available at: http://www.seas.upenn.edu/sys/morlokpage/rsdproject.html.

LIST OF FIGURES AND TABLES

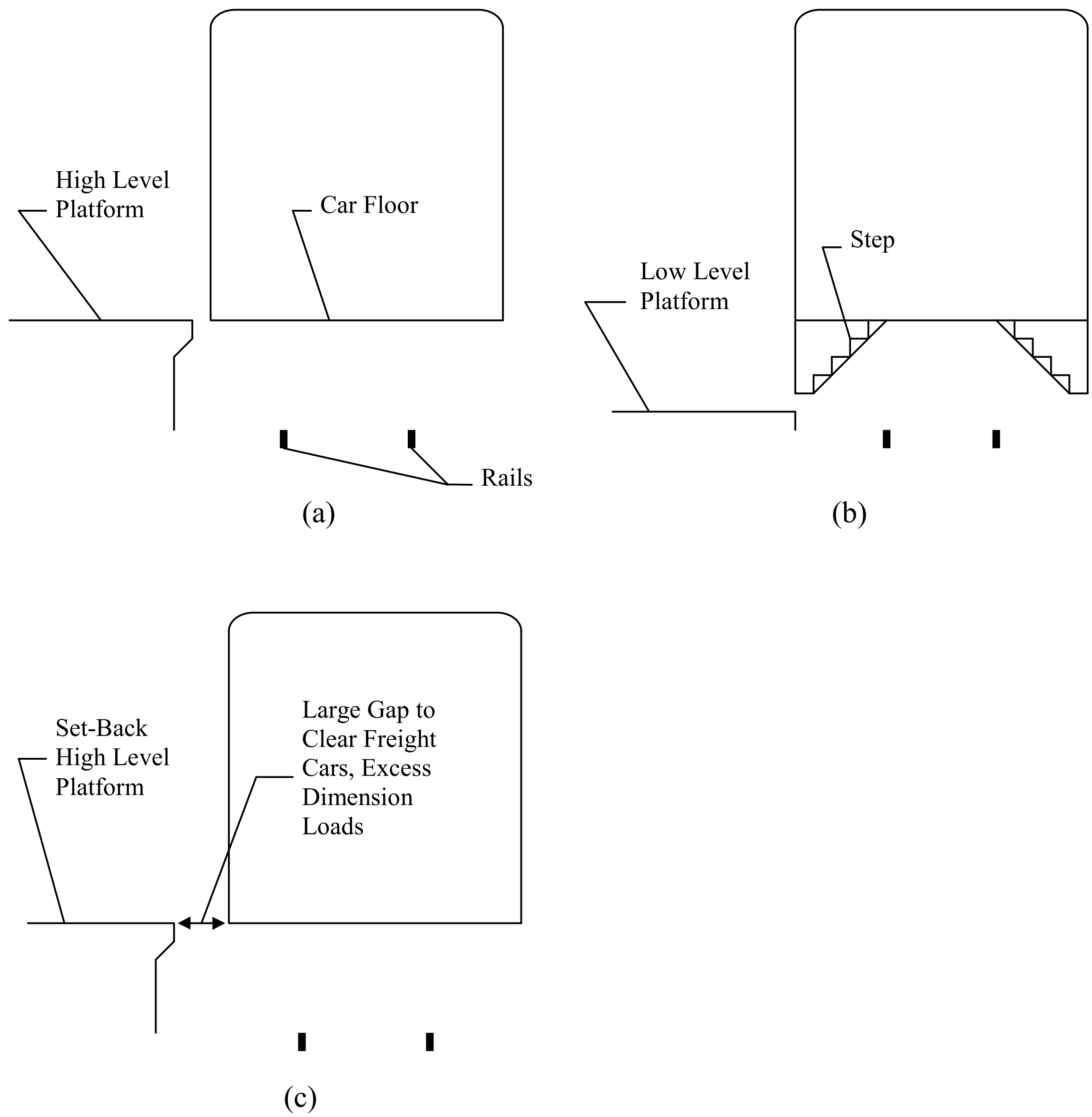
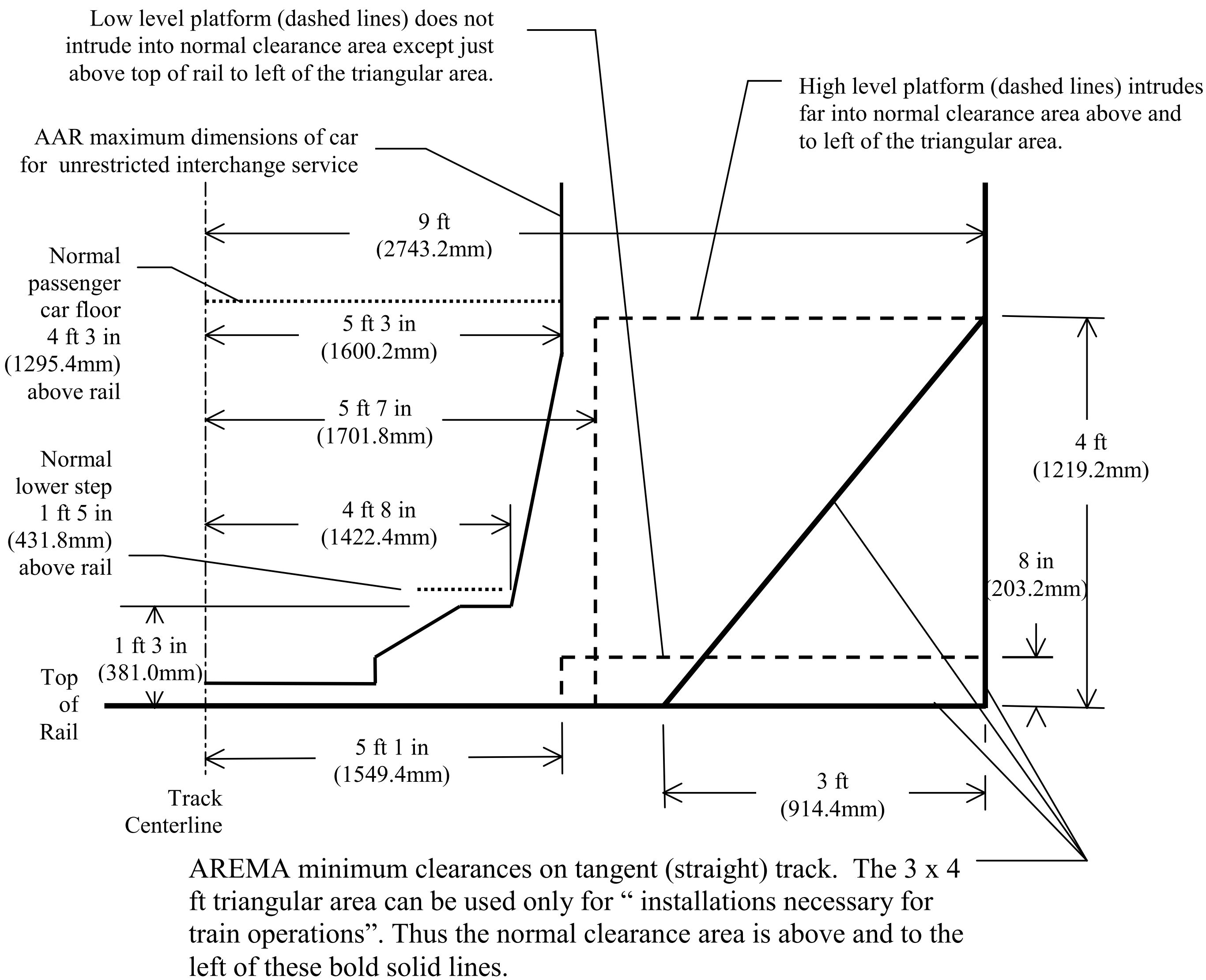
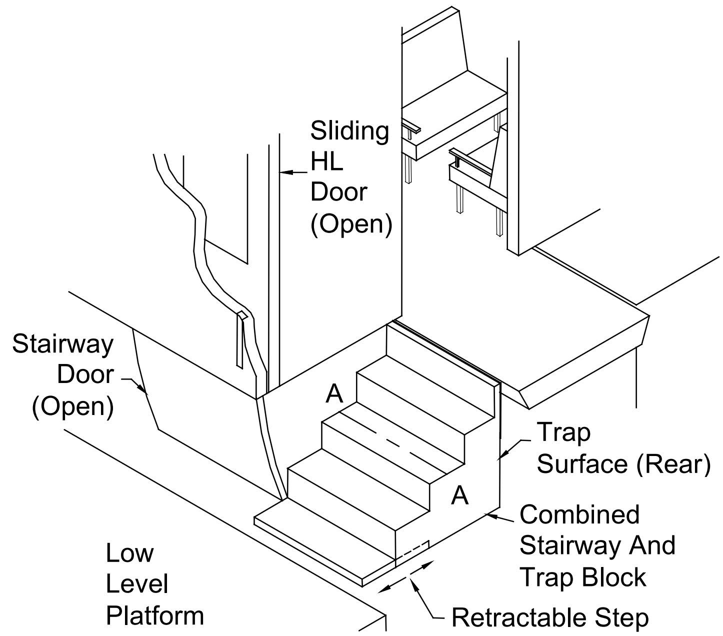


FIGURE 1. Types of Railroad Platforms: Schematic Cross Section Views of (a) High Level, (b) Low Level, and (c) Set-Back High Level Platforms.

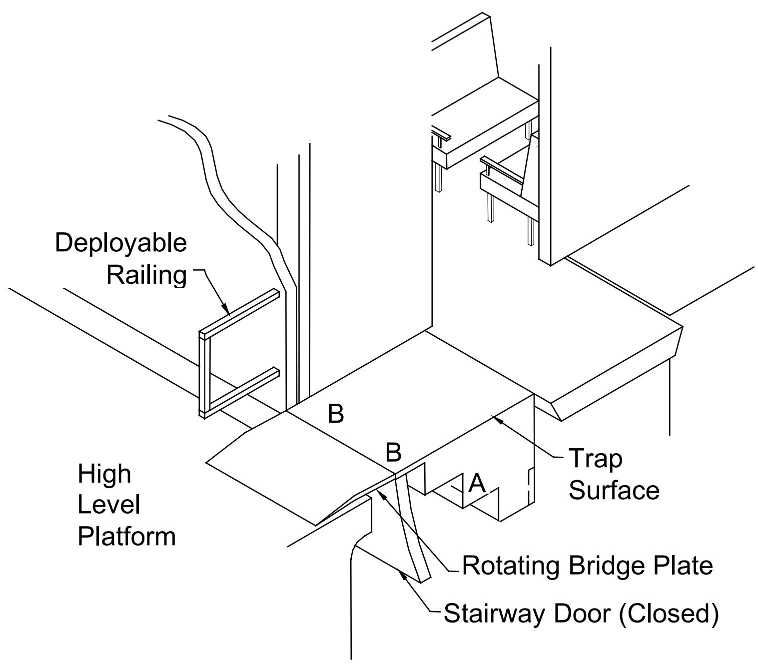


Notes: See text for explanation. Drawing shows only dimensional limitations where platforms and car entranceway doors would be located, up to approximately 12 ft above track. Other restrictions apply near the maximum height of cars. Sources: (2) and (3).

FIGURE 2. Railroad Standards for Car Size and Clearances Showing Locations of HL and LL Station Platforms.



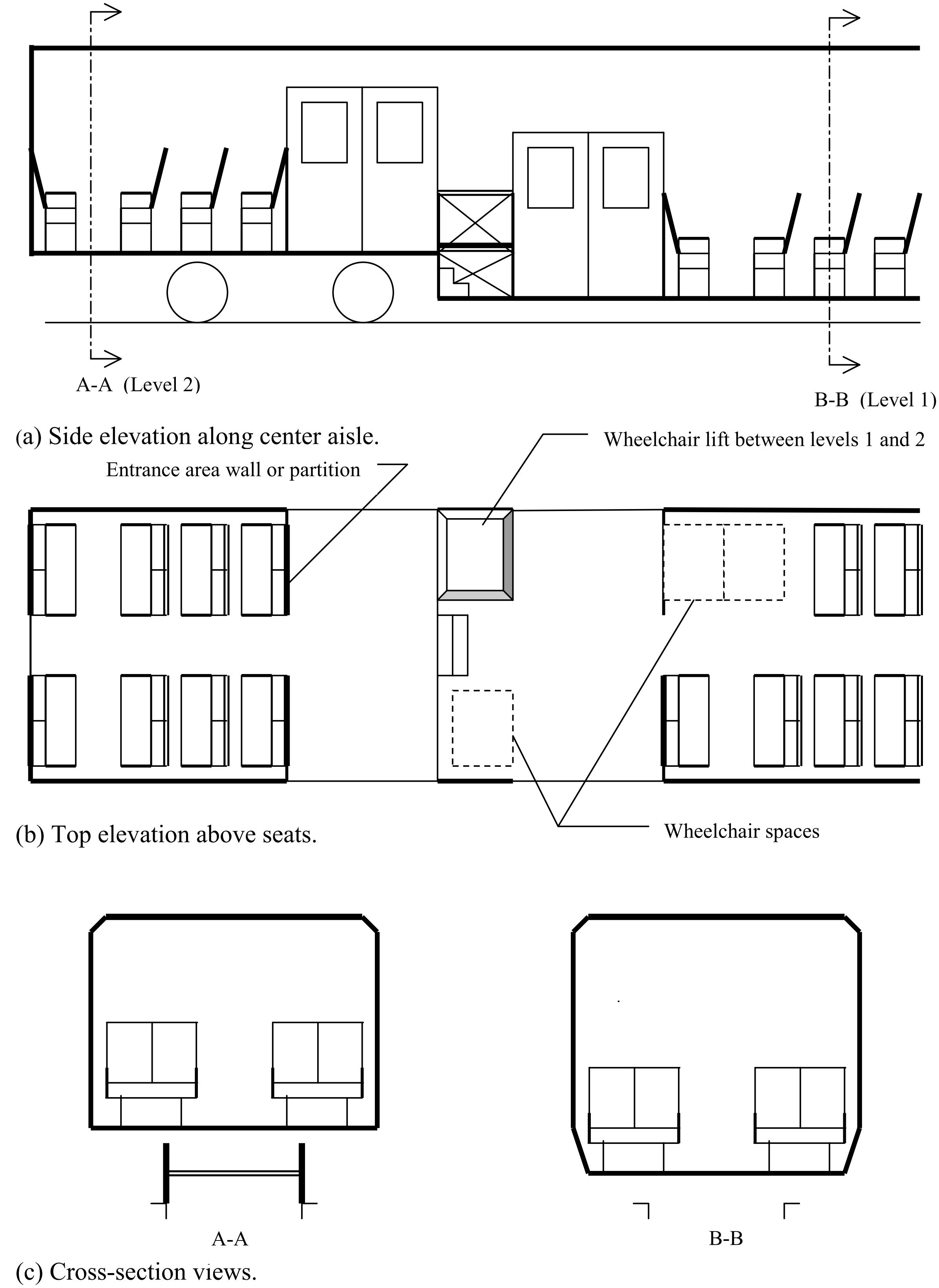
(a) at Low Level Platform.



(b) at High Level Platform showing Automatic Bridge Plate to Meet ADA Requirements.

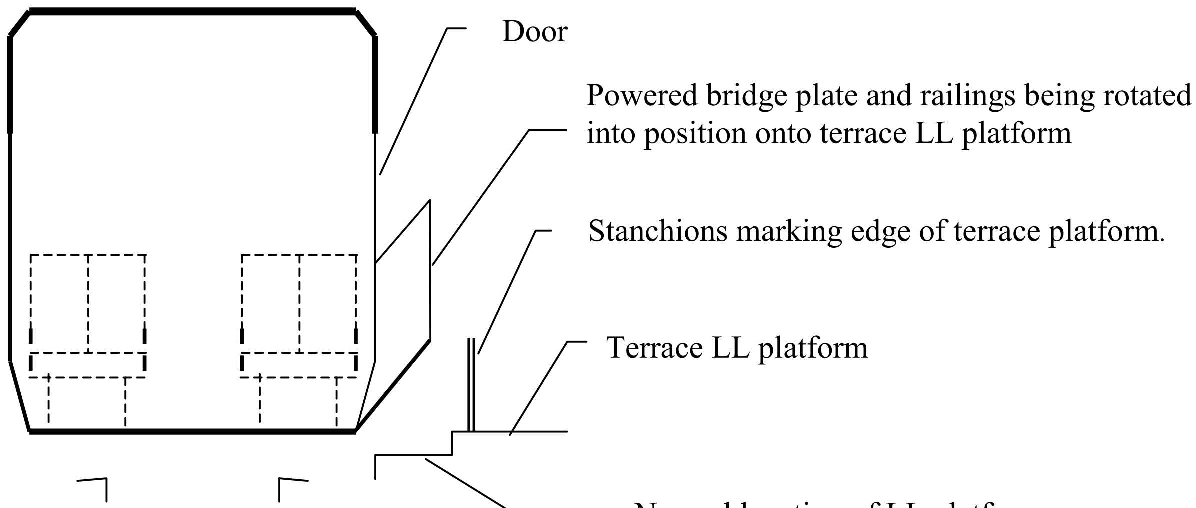
Notes: (1) Entire car body to the right of the entranceway--seating area or end wall—is omitted for clarity.
(2) HL platform can be set back to provide clearance for freight trains.

FIGURE 3. Design 1: New Entranceway for Low and High Level Platforms with Automatic Bridge Plate for ADA Access at High Platforms Only.



Note: Only half of car is shown in (a) and (b).

FIGURE 4. Design 2: Car Body and Entranceway for ADA Access at Both Low and High Level Platforms.



Note: Seats are shown by dashed lines, and the usual partitions or wall and door separating the entranceway from the seating area are omitted.

.

FIGURE 5. Design 2 Entranceway at Low Level Platform with Added Terrace Platform.