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

by

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ABSTRACT

Serious problems result from the use of both high and low level station platforms on U.S. commuter 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 problems accommodating freight trains on tracks with high level platforms. Various partial solutions to these problems have been proposed, and many are being used. However, none deals effectively with all of the problems. The benefits of a single comprehensive solution are identified, including improved service, increased ridership and revenue, meeting ADA accessibility requirements, and reduced costs. To indicate the importance of a solution to these problems, and to encourage thinking about solutions, some order-of-magnitude estimates of these benefits are developed. Finally, one design for dealing simultaneously with all of the problems is presented.

INTRODUCTION

There are three objectives for this paper. The first is to describe problems resulting from the use of both high level station platforms (HLPs) and low level platforms (LLPs) on commuter railroads—common in the Northeastern part of the U.S. and to a limited extent elsewhere. This will include a discussion of recent methods for dealing with these problems. The second is to identify the operational and financial benefits that would result from a more effective means of accommodating the two platform types, with some quantitative results. This is presented in a generic way, independent of any specific solution, in order to indicate the importance of finding a solution and to encourage work on the problem. The final objective is to briefly describe a new approach to the problem, in the form of a new entranceway design for passenger cars that must accommodate both platform types.

THE PROBLEM

Two different types of passenger station platforms—with some variations--are used on U.S. commuter railroads, particularly in the Northeast. Their use creates problems for car design, and can have negative effects on operations, service quality, and service economics. Some of these are derived from the fact that commuter railroads use the national U.S. railroad freight and passenger network, and this joint use imposes several requirements on facilities and rolling stock.

Traditional Platform Types and Entranceway Designs

Platforms

The two traditional platform designs are low level platforms (LLPs) and high level platforms (HLPs). These are illustrated in Figure 1. The LLP design is the oldest, and it is found at most suburban stations and many large city stations. AREMA (formerly

AREA) design specifications call for its top surface 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 (1, p. 28-1-6). (These dimensions are important later in the paper.)

Around 1900, a few HLPs were introduced, primarily at stations with many passengers boarding and alighting trains, to speed loading and unloading. Similar reasoning has led to rebuilding many stations with HLPs. HLPs 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 (1, p. 28-1-6). (Two recently introduced variants of HLPs are discussed later.)

Entranceway Design

The mixing of LLPs and HLPs on the same rail line has necessitated a special design for the entranceway to railroad passenger cars. Each entrance consists of a high level (HL) door, stairway, and trap arrangement as shown in Figure 2. At HLPs only the HL door is opened. At LLPs, the trap must be raised once the door is opened. (The trap normally extends under the door, though not in a new design—discussed later). The raised (open) trap then allows passengers to use the stairway. Almost all commuter cars that are currently used on lines with both HLPs and LLPs 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. The use of this entranceway design with LL and HL platforms results in many problems, which are grouped into six categories and discussed below.

Resulting Problems for Passenger Service

Problems resulting from the mixing of platform types are summarized into six categories: increased LL station dwell times, increased accidents and injuries, LL boarding and alighting difficulty, difficulty meeting ADA accessibility requirements, increased capital and operating costs, and inadequate freight clearance past HL platforms.

Long LL Station Dwell Times

At LLPs, as a practical matter, there are usually insufficient crewmembers to open and close all traps at each station. Common practice is to open only some traps and doors, and to leave them open between stations (especially where stations are closely spaced). Other doors and traps remain closed. This practice necessarily increases the dwell time at stations, as passengers take longer to board and exit the train.

The open entranceways also add to the dwell time. When trains arrive, passengers are generally forbidden to enter the vestibule area until the train stops, delaying the alighting process. At departure, if there are fewer crewmembers than open entranceways (as is typical on many lines), crewmembers must check car aisles and the train exterior to ensure that no more passengers are likely to try to board or alight as the train starts. The combined delay from these two sources will be referred to as the "insecure LL entranceway delay." This delay also increases run times.

Where manual doors remain, even at HLPs, only some doors are opened, leading to the same problem of increased dwell times. Clearly the result in both cases is poorer service from the passenger's standpoint.

Accidents and Injuries

With entranceways left open between stations, many accidents and injuries occur. Passengers can and do try to jump onto or off moving trains. In 1999 the rate of injuries to passengers while boarding or alighting trains on SEPTA commuter rail lines, on which doors remain open in most of the suburban area, was 2.31 injuries per million passengers (*11*). In contrast, on the Long Island Rail Road (LIRR) and Metro-North, which have essentially all remotely controlled doors that are closed between stations, the rate was only 0.22 and 0.25, respectively. Crewmembers are also at risk. The open entranceways are clearly a safety hazard.

LL Boarding and Alighting Difficulty

A further problem with conventional LLPs 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 (*1*, p. 28-2-1). Plate B is the one designated for normal interchange service. The bottom step tread should be, by design, 5 in. (127 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 at some stations, creates an identically high first step.

Various means have been used to try to solve this long-standing problem. In the past, a train crewmember would place a "box step" at each entranceway, but smaller crews make this infeasible. Some commuter rail agencies have begun using "step-up platforms." These are wooden platforms approximately 7.5 in. (190.5 mm) high by 16 ft. (4876.8 mm) long (in two sections) placed on top of LLPs, functionally similar to the box step. It is lightweight and slides so that if a passing train hits it, no derailment will occur, though the platform movement creates a safety hazard. Finally, one line—NICTD—has added a permanent additional lower step on its cars, but this extends beyond AAR Plate B limits. Thus the LL first step gap problem remains.

ADA Accessibility Requirements

The problem of mixed platforms has recently become even more difficult, because of the need to accommodate mobility-impaired passengers. To accomplish this, many agencies are installing a mini-HL platform at many stations with LLPs. These are short, about 20 ft (6096 mm) in length, to reduce costs. The high level permits the conductor to place 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 process permits rolling a wheelchair between the platform and train, but is labor intensive and time consuming.

The 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 1.5 in.(38.1 mm) (3). For 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. Current passenger cars are 10 ft ((3048 mm) wide at the floor, so the gap to a HLP is 7 in. (177.8 mm). 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 cannot be met without some type of bridge plate.

In addition, there could be a slight lengthening of schedules to accommodate mobility-impaired riders, since the dwell time is likely increased. Often two stops are made, one at the regular LLP, and another at the mini-HLP.

Capital and Operating Costs

All of the above factors can have a negative effect on costs. The labor intensive entranceway design places a minimum requirement on crew size, although that size is also affected by ticket collection and pass inspection. Where crewmembers are paid by the hour, the increased running time directly increases labor costs. Where crewmembers are paid on a mileage basis, the effect on labor costs is less clear, although various local adjustments may be affected by running times as well. Similarly the increased run time will tend to increase the cycle time of equipment, and thus could lead to more cars and locomotives being required.

Resulting Problems for Freight Service

While the design requirements on passenger platforms should in principle enable joint use of lines by both freight and passenger trains, in practice serious problems exist with HLPs. The latest *Car and Locomotive Cyclopedia* (4) reveals that many recent freight cars are wider than passenger cars, many being the 10 ft 8 in. (3251.2 mm) maximum permitted by Plate B. The standard HLP was designed to clear such equipment with a 3 in. (76.2 mm) gap (allowing some lateral shifting in a dynamic envelope).

However, the reality of operation with HLPs is more problematic than the standards suggest. It is very difficult to ensure that the exact distance between track and platform is retained in practice, because when tracks are maintained, they can be moved vertically and horizontally. Also, some enclosed freight cars are operated with their side doors open when empty, in order to ventilate the interiors, and to ensure that any illicit riders are not trapped inside. Open doors can strike an HLP, with disastrous results for the platform, train and bystanders. As a result, freight railroads generally oppose HLPs.

It is important to note that the issue of incompatibility between HLPs and freight service has become moot in some cases. Freight traffic has been withdrawn on some lines. However, rail freight traffic overall has been growing for many decades. Thus elimination of freight service from commuter lines is not a viable option and would have obvious negative impacts as well.

CURRENT (PARTIAL) SOLUTIONS

Inside Trap and Two-Level Door

The problem of being able to open only some entranceways at LLPs has been overcome by an ingenious design that is installed on some NJ Transit cars. This design involves two related innovations. One is that the trap extends only to the inside of the door, so that it can be raised or lowered while the door is closed. The second feature is a lower level panel door for the stairway, which is closed when the trap is down and which forms the extension of the trap toward the HLP. This door slides open and closed with the HL doors when the trap is up, enabling use of the stairway for LLPs. Thus it enables remotely controlled opening and closing of doors at LLPs, as well as at HLPs, with attendant labor saving, dwell time reduction, and safety benefits. The remaining manual operation, that of moving the traps, can be accomplished while the train is in motion. However, this design does not deal with the ADA, LL first step gap, or freight clearance problems.

Two Sets of Entranceways

Montreal's electric MU cars have two sets of entranceways, one a center HL doorway and the other end vestibule stairway and doors for LLPs only. All doorways are double lane and remotely controlled. This quite effectively solves the same problems as the prior approach, but not the others. The price is the loss of at least two rows of seats due to the extra center doorway—an important loss in commuter service where passengers expect to be seated.

Remotely Controlled Trap and HL Door

In this new design (installed in cars for VRE) the trap is powered so that it can be raised or lowered by remote control. Combined with remotely controlled HL doors, this then enables opening and closing all doors at LL platforms, with labor, safety and at least some dwell time saving. The time saving is diminished by the need to wait for the trap to be raised at LLPs, after the HL door is opened. It, too, does not deal with the ADA, LL first step gap, or freight clearance problems.

Hi-Lo Steps

The problem of HLPs and LLPs on light rail lines is solved by having steps that move vertically to provide both LL access (with steps in the lowered position) and HL access (with the steps raised to form a surface level with the car floor). There are numerous design variations, but the functionality is similar. In principle, this idea could be transferred to railroad cars, although the AAR Plate B clearance envelope requirements might be difficult to meet. Like the other step designs, this does not deal with the ADA, LL first step gap, or freight clearance problems.

Separate or Gantlet Tracks for Freight Service

Three approaches have been used to ensure compatibility between freight and HLPs (but not address the other problems). One is to provide a separate track (with switches at each end) around the HLP, or equivalently a separate main track along the entire line. This approach is costly, but effective. Another is to provide a gantlet track, parallel rails that are offset about one foot (304.8 mm) from the passenger rails, with a switch at each end. This too is costly, and usually requires a restricted speed in entering and leaving the gantlet track—features making gantlet tracks generally undesirable except on low speed lines.

Retractable-HLPlatforms

The third alternative is the retractable-HLPs. A foot (304.8 mm) or so of the trackside edge of the entire platform (normally at least 300 ft (91440 mm) long) is retractable, so that it can be moved out of the way of freight trains. Current designs all seem to achieve this by rotating this section upward. One version, used by NJTransit requires manual rotation, in sections. On at least one occasion, the platform was struck by a freight train. This possibility resulted in a further design variation, in which the moveable sections are designed to be easily replaced if struck. Some agencies use narrower gangplank-like designs with mini-HLPs. Another possibility is the gap filler used on some curved rapid transit platforms. All these result in added installation and operating expenses, and can be difficult to maintain.

BENEFITS OF EFFECTIVE SOLUTIONS

Clearly none of the approaches described above successfully deals with all six problems identified earlier. Since one purpose of this paper is to spur exploration of innovations that would solve these problems, the benefits that would follow from a comprehensive solution will be discussed. These benefits would have to be weighed against the costs of any specific solution, of course.

To provide some idea of possible magnitudes of benefits, a specific example commuter rail line must be used. Values are chosen to be typical, but where specifics are needed the R3 Media-Elwyn-Philadelphia line of SEPTA is used (*5*). This line is 15.5 miles long (to Market East station). Local trains require 45 minutes for a one-way trip. Service is approximately hourly in the off-peak periods, more frequent in the peak periods--including four expresses each way daily. Electric MU cars are used (though sometimes a push-pull set is used for one express). The three CBD stations and one adjacent station (all major work-trip destinations) have HLPs. All others have LLPs, some of which were installed or rebuilt recently. Five have mini-HLPs for wheelchair passengers. All cars have the usual end vestibule traps and remotely controlled doors (except for a few older cars). Normal track assignments result in right hand side platforms at all LL and two HL stations, left hand side platforms at two HL stations.

The benefits to be considered fall into four categories:

1. Reduced run times, with ridership (and revenue) gains.
2. Reduced operating (and possibly) capital costs.
3. Possibly increased train frequency, with ridership (and revenue) gains.
4. Enhanced clearance for freight trains.

Emphasis is given to quantitative benefits, for which a monetary value can be given. Clearly there are other benefits, some of which are not readily evaluated monetarily, and others that in principle could be but for which the necessary value data are unavailable (e.g., reduced injuries).

Reduced Run Times with LL Platforms

Reduced run or train trip times will result from reduced dwell times. There are two cases to be considered, one in which LLPs are retained, and the second where these are replaced by HLPs.

In general opening all doors at all stations with LLPs will reduce dwell time at stations, as will the more easily used stairway (from eliminating the LL first step gap). These changes will speed service for all passengers.

The magnitude of the reduction is somewhat conjectural at this point. Current evidence suggests that passenger flow rates per entranceway lane are, on average, about 3.25 sec./passenger for boarding an LRV with steps, and 3.65 sec./pass. for alighting (6). Commuter rail times might be longer, given the greater floor height and the first step gap. On this line, the increased number of open doors will undoubtedly speed service. Since the engineer occupies the "front" entranceway on the first car of the train, this car has only one entranceway open. Thus the time reduction for this car will likely determine most if not all the savings. For purposes of illustration, the reduction is assumed to be 0.75 sec./pass. (Sensitivity of results to changes in assumptions will be discussed later).

The LLPs are used at the suburban end of a passenger's trip. Assuming a full car (seated load), and assuming that 15% of the passengers board at the origin station (so savings there do not affect run time), the time saving over an entire run are:

(0.75 sec./pass.)(127 pass)(0.85)=81.0 sec.=1.35 min.

In addition, there is a time saving due to the doors being closed when it is unsafe for passengers to board or alight, eliminating the insecure LL entranceway delay. The time saving must be assumed; a value of 10 sec. seems reasonable but probably is very conservative. With 13 stops, the saving is 130 sec. (2.16 min.). Thus the total saving is 3.51 min.

This will be taken (conservatively) as a reduction of 3 min. out of the overall run of 45 min. (6.7%). Evidence on the response of travelers to changes in transit in-vehicle time suggests that such a reduction in time, while small, would increase the number of riders, and hence revenue. There appear to be no demand elasticity values based on observations of rail service time reductions, so values based on bus service speed–ups must be used. Indirect support for this is provided in the 2001 TCRP traveler response handbook: "These data suggest that commuter rail patronage responses to frequency changes are in the same general realm as bus ridership responses on routes with similar demographics and original service frequencies" (*7*). Assuming the same transferability applies to travel time, these values should give some indication of the likely response.

Menhard et al. (*8*) give the elasticity of demand with respect to in-vehicle time as -0.29 for the peak, and –0.68 for the off-peak period. In applying these values, the strict constant elasticity demand model form is used instead of the proportional difference approximation, since the error inherent in the approximation is excessive in a later analysis. (The correct model is $d=At^B$, with d the demand, A a constant, B the elasticity, and t the in-vehicle travel time (*9*). A change in travel time, from t_1 to t_2, results in the new (d_2) vs. old demand (d_1) given by $(d_2/d_1)=(t_2/t_1)^B$. The approximation $(d_2-d_1)/d_1=B(t_2-t_1)/t_1$ is reasonable only for small changes in d and t.)

The effect of the 6.67% reduction in in-vehicle time is thus estimated to be an increase in riding (and hence in revenue also) of:

Peak: + 2.0%
Off-peak: + 4.8%

While small, these increases are not trivial. The off-peak gain is particularly significant, because the additional cost to accommodate such increased riding is probably essentially zero (due to excess seats on trains).

Of course these numerical results are only indicative of a possibility, because some input values are uncertain. Not considered was another source of decreased dwell time--that resulting from accommodating wheelchair (and other mobility impaired) riders more expeditiously. This will not only speed the service, but also reduce and possibly eliminate any slack incorporated in current schedules for accommodating such riders.

At these small values of service and ridership change, the impacts are roughly proportional to one another. For example, if the time saving were doubled (to 6 min.), then the estimated increase in off-peak riding would be 10.2% (slightly more than twice 4.8%).

Reduced Run Times with HLPs

Another option is to provide HLPs throughout. These would be of the RH type, or equivalently of a type that provides adequate clearance for freight trains. The effect of reduced run times can be approached in the same way as previously for LLPs. The TCRP#13 report gives average floor level (i.e., HL) boarding and alighting times as 2.00 and 1.50 sec/pass. for medium volume conditions (vs. high volume, though the values are about identical) (6). The differences with LL is thus 1.25 and 2.15 sec./pass, respectively. Taking 1.7 sec./pass. as an average reduction, the saving becomes:

(127 pass.)(1.7 sec./pass.)(0.85)=183.5 sec.=3.06 min.

The constant dwell is reduced identically to that with LL platforms, by 2.16 min., for a total saving of 5.22 min.

Using a value of 5 min. (for a saving of 11.1% on the 45 min. run), the increase in ridership and revenue would be:
Peak: + 3.4%
Off-peak: +8.3%

As expected, these increases are somewhat larger than those with retention of the LLPs. The incremental gains could be used to justify the added expense of HLPs.

Reduced Costs

With remote control of all doors from a single location, the number of crewmembers required for entranceway-related tasks is reduced to one. Two-person crews (conductor and engineer) are used on some commuter rail lines, even with long trains. This requires that fare collection be done in a compatible way, such as with a proof-of-payment system. Even with some ticket inspection on long trains, some crew reduction should be possible.

The impact of small crews can be appreciated from 1999 data on the percentage that train-operating labor (salaries and wages) represents of total operating cost for selected commuter rail operations. For the major carriers in the northeast that have problems with a combination of HLPs and LLPs (MBTA, NJ Transit, and SEPTA), the percentage is in the range of 13.7 to 18.2% (2, Table 12). By contrast, the lines that are equipped exclusively with HLPs or LLPs, and whose equipment includes all or almost all remotely controlled doors (LIRR, METRA--all LLPs except for one separate all-HLP line, Metro-North, and SCRRA), have percentage values in the range of 9.1 to 11.4%. The difference is about a one-third reduction in crew costs. (Other carriers in the database have no breakdown of operating labor, except NICTD, for which the data appear inconsistent, with a very low "operating" labor value, but a very large "other" labor value.)

It is also possible that the fleet size can be reduced, as a result of the reduced cycle time. This would reduce capital costs and time-based maintenance costs. It is difficult to generalize about the potential fleet reduction, however, because of the long and typically irregular headway on commuter rail lines during the peak period that determines fleet requirements.

The cost savings could be absorbed directly to improve financial performance, or might be translated into service improvements, through increased train frequency, reduced fares, or other service improvements.

Increased Frequency

Once the cost of operating trains is reduced, the optimal frequency is likely to increase. Elasticity estimates for commuter rail service frequency are presented in the TCRP 2001 ridership response handbook. The range of values is +0.5 to +0.9, with no differentiation between the peak and off-peak (7). The midpoint of the range, +0.7, is used. Since the (midday) headway is now one hour on the line in question, halving it seems natural, to maintain a clock headway. The estimated increase in midday ridership is 62.5%.

Would such a doubling of frequency yield revenue sufficient to offset the added cost? Estimating cost and revenue changes is made difficult by the complexity of rail operations, and the interdependence of costs for one train (or period) on the operations in another (e.g., use of labor between the peak, base, and evening). Assumptions must be made.

Assume that the new train would be the same length as those now operated, and that this is two cars, with a crew of three persons. With the new entranceway, and possibly concomitant changes in fare collection, two crewmembers should be sufficient. It is assumed that labor costs vary with actual requirements on trains, and that an engineer costs $40/hr. and a conductor $30/hr. Further assume that the long-run marginal cost of car-miles (primarily energy and some maintenance) is $2/car-mile. Assume that the current ridership on the average two-car midday train is one-third of its capacity (2 x 127 seats/car), or 85 passengers, and that the average midday fare is $2.

The results of this comparison are shown in Table 1. The net gain (per hour of operation) to the operating agency is $30 with no change in service. The increased service results in a net gain (added revenue less added costs) of $36. Clearly the increased frequency is worthwhile in this example. Obviously this analysis is only suggestive, and different conditions (and assumptions) will affect the result. The doubled frequency might be operated with some trains of only one car instead of two. Ridership increases may be greater, or smaller, as the range of elasticity values was quite large. And costs might be quite different. Some labor may be available at almost zero additional cost, but on the other hand, some additional compensation may be necessary for unions to accept smaller crews.

A similar analysis could be done for the peak period as well, although commuter rail frequencies are generally much better during this period. The cost impact of increased peak ridership would in general be much greater, of course, as additional equipment and labor (possibly with a minimum full day's pay) would be needed. Other (mainly external) benefits external have not been included, such as reduced congestion from shifting travelers from autos to rail.

Line capacity and other train traffic may preclude frequency increases. But many commuter lines in the Northeast have little other daytime traffic, freight service often being provided at night.

In summary, the analysis does indicate that improvements in entranceway design could have impacts not only on service quality but also on the economics of commuter rail operation.

Compatibility with Freight Service and New Passenger Services

A final and very important advantage of the changes identified earlier is the compatibility with freight service. A corollary benefit is that new rail service along freight railroad lines can be introduced with much less cost than if an entirely new right-of-way (ROW) and trackage were required—at a cost of tens of $millions/mi.. This assumes, of course, that sufficient track capacity or ROW for additional tracks exists.

A NEW ENTRANCEWAY DESIGN

This new design is intended to overcome all of the problems described earlier. It combines the stairway, trap, and a built-in bridge plate so as to provide full access and door security with both HLPs and LLPs. It is also designed to bridge the gap to a HLP set back (away from the track) by about 6-9 in. (152.4-228.6 mm) from the normal location (designated a "set-back-HLP"), so that it provides adequate clearance for freight trains. Transition of the entranceway from its configuration for one type of platform to another can be accomplished from a single location on the train. This design includes two doors--the usual remotely controlled HL sliding door, and a second stairway-level panel (stairway door), to fully cover the openings. A brief description of the basic design, called MetroDoor I, follows; details are provided in (*10*). The name comes from the "metropolitan corridor" designation of the Northeast Corridor, and the use of "metro" for some new commuter rail lines.

LL Platform Operation

Essential features of the design are illustrated in Figure 3. The stairway and trap can be considered a block, which rotates about the axis A-A to provide access for the different platform types. Figure 3a shows the block in position for a LLP, with the two car-side doors open. A sliding lower step can be extended at LLPs, to eliminate the first step gap problem (but not deployed if the platform that is unusually high or close to the train). Both doors are opened simultaneously, and closed simultaneously, thus eliminating the open entranceway safety problem. The sliding step is retracted after the LL door is closed, so that the car conforms to the AAR Plate B when it is moving.

Transition between LL and HL Platforms

When traveling from a LLP station to a HLP station (or vice versa), the configuration of all of the entranceways (on one or both sides) of the train can be changed by remote control. The block is rotated about the axis A-A, as shown in Figure 3b, stopping when the trap is horizontal. To do this one of the two car-side doors must be opened—depending on the direction of rotation. (Both doors are shown open in the figure simply for clarity.) Attached to outer edge of the 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 HLPs to LLPs.

To ensure passengers are not be in the stairway-trap block area, an interior door is locked closed. This door is either the traditional vestibule's passenger compartment door (designated C in Figure 3b), or a door located just inboard of the stairway-trap block area (at location D). Passenger detectors (of weight, presence, etc.) are used to ensure that no one is in the area during transition.

Currently, conventional traps are repositioned while traveling between stations (with the doors opened, except where an inside trap is used), and the same timing would apply to the Metro-DoorI.

High Level Platform Operation

Upon arrival at a HLP, the bridge plate is lowered (again all simultaneously, by remote control), so that it rests on the HLP and the entranceway railing on each side of the bridge plate would descend (as shown in Figure 3c). Then the HL doors are opened. Once all passengers have passed, the door is closed, the bridge plate raised (rotated upward against the outside of the HL door), the railings raised (into the car side), and the train departs.

To ensure that the stairway-trap block, doors, and appurtenances are in their proper positions at all times, interlock devices are incorporated. A detector along the tracks could also be used.

Compatibility with Various Car Designs and Entranceway Locations, and Platforms

Since the bridge plate is designed to completely cover any gap between a HLP, mini-HLP, or set-back-HLP and the train entranceway, the ADA accessibility problem, and the more general safety problem with a large trap-to-platform gap, is eliminated. The use of a set-back-HL platform eliminates the need for retractable HLPs (and the attendant costs and safety problems) where clearance must be provided for freight trains.

A very important feature of the MetroDoor I design is its compatibility with both new car designs and existing cars. The design is compatible with different entranceway locations—center of body, quarter points, or ends--and varying widths (topically one to three passenger lanes per entranceway). It is also intended to replace the trap-stairway-door assemblies of existing traditional vestibule cars. In fact, most intercity cars with end vestibules now have rotating stairway blocks for the two or three lower steps. These do not rotate a full 90 degrees, because their purpose is simply to provide a smooth streamlined exterior. (See *4*, p. 347 for an example.) Thus the MetroDoor I design is compatible with all of the standard passenger car body configurations used on mixed HLP and LLP railroads.

CONCLUSIONS

Arguments have been made that the six problems that beset rail commuter lines in connection with the mixing of HLPs and LLPs are serious, and that attention should be given to trying to find solutions. A case has also been made that a solution could have rather significant benefits, in improving service quality, reducing costs, and increasing ridership and revenues. Finally, one example of an entranceway design for a railroad commuter car that appears to overcome these problems has been presented.

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List of Tables and Figures:

TABLE 1 Example Outcome of Reduced Operating Costs and Increased Midday Frequency.

FIGURE 1 Commuter Railroad Low Level (LL) and High Level (HL) Platforms.

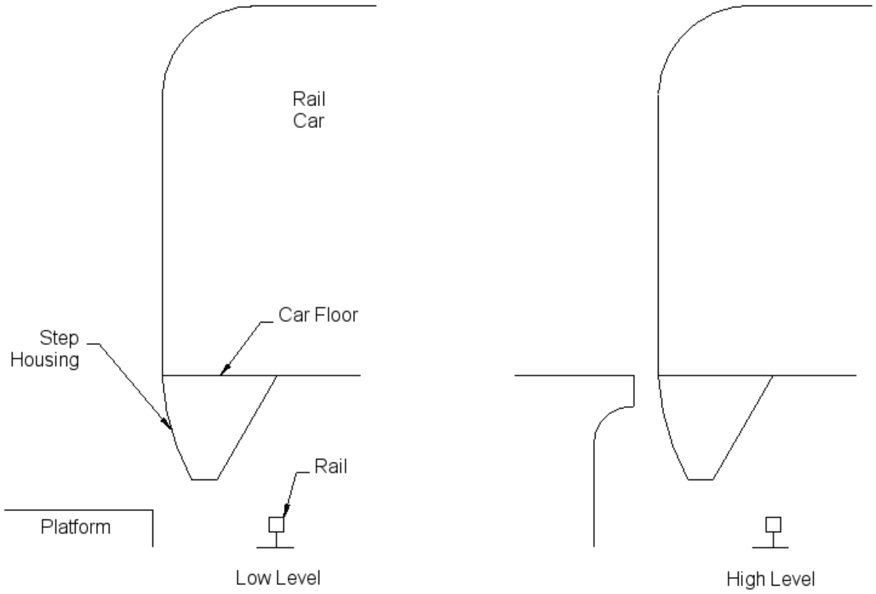
FIGURE 2 Traditional Railroad Entranceway Design (with End Wall of Car Omitted for Clarity).

FIGURE 3 New Entranceway Design (Metro-DoorI) (with Entire Car to Right of Entranceway Omitted for Clarity) (a) at Low Level Platform (c) at High Level Platform and (b) transitioning from LL to HL between Stations (with an Inside Door—either at Location C or D—Closed and Locked during Transition).

TABLE 1 Example Outcome of Reduced Operating Costs and Increased Midday Frequency.

	$/hour of Operation per Direction		
Change in Operations and Service	Change in Cost	Change in Revenue	Change in Surplus
Smaller Crew Size	- 30	0	+ 30
Double Frequency	+ 70	+106	+ 35

Note: All values are rounded to the nearest whole dollar.



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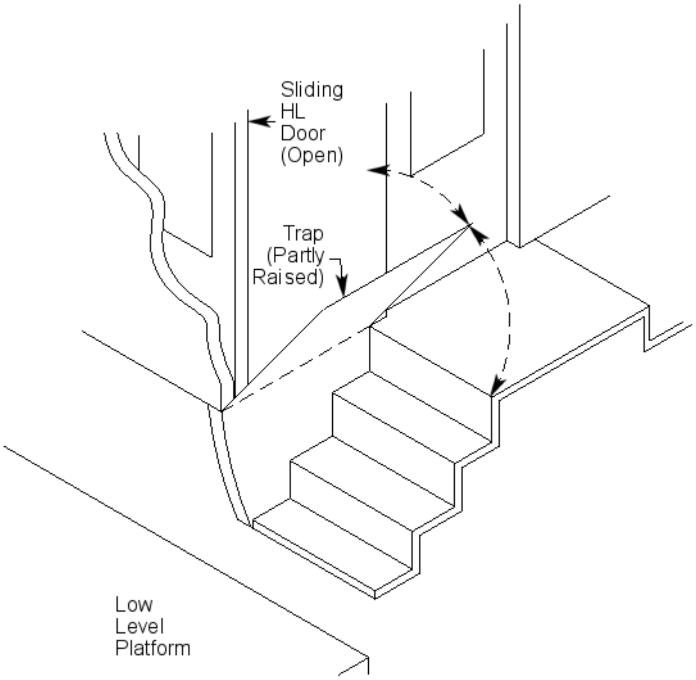

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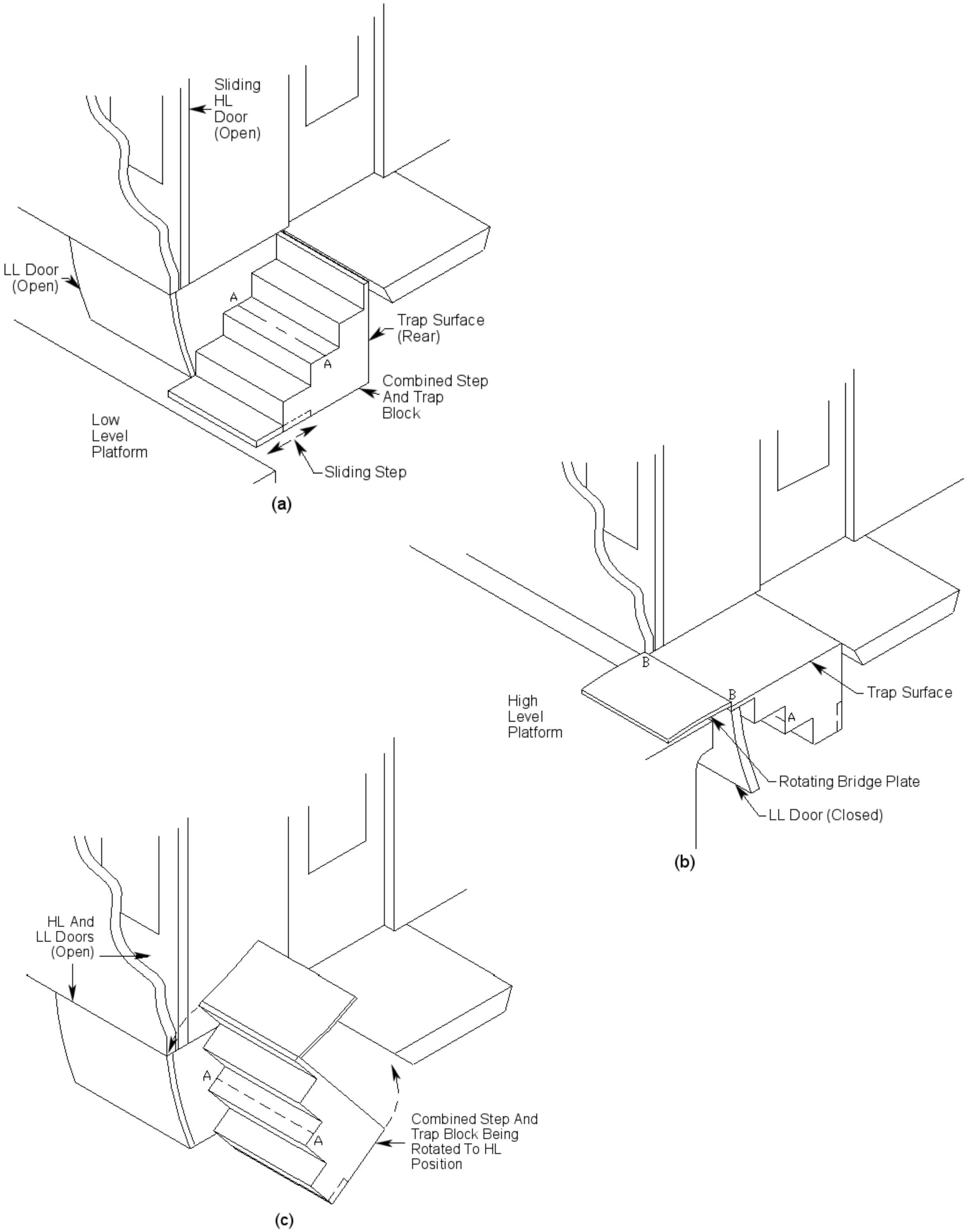

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