

# **ENTRANCEWAY AND CAR BODY DESIGNS EBD 4.1 and 4.2 - VARIATIONS ON EBD 3.1 WITH REDUCED OVERALL HEIGHT AND INCREASED UNDERFLOOR SPACE FOR STRUCTURAL MEMBERS**

by

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## 1. Abstract

This design provides is intended to solve many pressing problems associated with rail passenger and freight service in the Northeastern U.S. It incorporates the following features of EBD 3.1:

- It provides remote-controlled at standard high level (HL), mini HL, and low level (LL) station platforms and meets ADA accessibility requirements.
- It has three levels, thus increasing car capacity over conventional single level cars by about 20 to 36%.

Important additional features of this design are:

- It has a roofline only 14 feet 6 inches above the rail, meeting the most restrictive Northeastern clearances for passenger service.
- Its floor is 25 inches above the rail, permitting structural members to be placed below the lower floor. This should simplify the meeting of compression strength requirements.
- To achieve this, either gallery seating or longitudinal seating is used on the upper level of the double-deck section of the car.

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## 2. Basic Car Body and Entranceway Design

The basic design follows that of design EBD 3.1, described in a separate document in this series (Morlok, 2002--references being listed on the last page). The essential differences are three. First, the roof is lowered to 14 ft 6 in above the rail. Second, the floor is raised to 25 in above the rail, to permit structural members to be placed below the floor. Third, the transverse seating on the upper level is changed to compensate for the smaller vertical size of the car body. Either of two seating arrangements can be accommodated:

1. Gallery style
2. Longitudinal, back to back.

An additional difference, though one that can be altered, is to reduce the number of doors—to two single lane ones for HL platforms, and to one double-lane one for LL platforms. This permits more spacious seating. Having fewer door lanes is not inappropriate, since LL doors are usually used at suburban stations where fewer persons board or alight compared to CBD stations. Thus the increase in dwell time from fewer door lanes is likely to be small. Of course, more doors or door lanes can be provided at each level if desired.

The entranceways would be equipped for ADA-compliant access in a manner identical to those of designs EBD 2.1 or 3.1. However, for approximately level boarding from a terrace platform, that platform would have to be about 16 in above the rail, 8 in higher than that for EBD 2.1 or 3.1.

### 2.EBD 4.1 Gallery Design

The basic gallery version is shown in Figure 1. As can be seen, the essential difference with EBD 3.1 is that level 3 now consists of two unconnected side galleries rather than a full width floor, and the number of LL doors is reduced to one (with 2 lanes).

Details of the seating and doors remain as in EBD 3.1, and thus will not be repeated here. This results in a car that has 128 seats, with the door arrangements in Figure 1. Its capacity is considerably greater than a single level car, approximately 96 to 100 with comparable seat pitch and number of door lanes.

The details of the cross section including headroom over aisles and seats, is given in Figure 2 (in two parts). Figure 2a shows the typical gallery arrangement with the gallery-level (level 3) aisle on the inside of the gallery. An alternative that provides more headroom over the level 1 seat next to the aisle places the gallery aisle on the outside next to the car wall. As shown in Figure 2b, by raising the seat area floor one step, 8 in is added to level 1 headroom. Full height headroom (greater than the usual doorway opening of 80 in) is provided over all aisles, of course.

If the car is equipped with a lift between levels 1 and 2 for wheelchairs, then the level 1 door must be moved slightly closer to the center of the car, and the number of seats is reduced to 120. The arrangement is shown in Figure 3. Some seats on level 1 and 2

would have to be collapsible, to provide space for wheelchairs as needed. If two wheelchairs replace three double width seats on level 1 or 2, then the number of regular seats would be 114.

Another variation is to place the level 1 door for LL platforms in the center of the car. This arrangement is shown in Figure 4. This reduces the number of seats to 122, for the non-ADA-compliant version, compared to 128 seats with the LL door at the end of level 1. However, the center location may be preferred to reduce the maximum walking distance from the seats to the door. If a center door is used for the ADA-complaint version, then the aisle leading to the lift would have to be sufficiently wide for wheelchairs, and there is the risk of the aisle being blocked by a wheelchair when other passengers desire to pass.

### 3. EBD 4.2 with Hedley-Doyle Seating

This design replaces the gallery with longitudinal seating, back to back centered on the upper level. Figure 5 provides the general layout (with the LL door at one end of level 1), while Figure 6 presents the cross section details. Again full height aisles are provided everywhere.

The primary benefit of the longitudinal seating is that the capacity is increased—to 136 compared to 128 for the case of a car without ADA features. Longitudinal seating has features which passengers may find attractive or annoying. An advantage is that each seat is on the aisle. Another is that the seats face outward (as on some hi-level lounge cars used by Amtrak, for example), giving a good view of the scenery. Yet another is the wide aisle on level 3 compared to that achieved with a gallery design. On the negative side, though, the level 1 aisle has a normal height ceiling, rather than the high one achieved on the gallery design. Also, almost all seats now share armrests on both sides. Thus the addition of the 8 seats per car may or may not be attractive overall.

Such seating was used on some experimental streetcars, designed by Hedley and Doyle and known as the “Hedley-Doyle stepless streetcars” because of their low floor entrances—a forerunner of the current generation of low floor light rail vehicles (Elsner 1997, pp. 8-9, 70). Their design was not widely used, but many factors contributed to their unpopularity-- including narrow aisles, resulting in long stop dwell times. They also had much more restrictive dimensions for seating and aisle width and height than those contemplated here. (A reproduction of a drawing showing the arrangement of stairs and seats appears in Brill, 2001, p. 117).

The effect of incorporating ADA compliant features is similar to that for the gallery design. The number of seats is reduced by about 8, to 128, as shown on Figure 7.

With this seating the LL door could also be placed at the center of the level 1 section. The same considerations apply in this case as were described for the gallery seating design EBD 4.1.

#### 4. Conclusions

A summary of the number of seats provided on each version follows:

Gallery seating, LL door at end, non-ADA-compliant	128 seats
Same, ADA-compliant	120
Gallery, LL door at center, non-ADA-compliant	122
Hedley-Doyle seating, LL door at end, non-ADA-compliant	136
Same, ADA-compliant	128
Split level car without double deck features, non-ADA-compliant, Based on EBD 4.1	100

The split level car without the double deck features is included both as a point of reference and to identify this design as an option. There may be circumstances where such a car would be desirable. It has the rapid access features and ADA compliance potential of these designs without the complication of a third deck. The addition of a third level over level 1 increases the seating capacity by 20% to 36%, compared to a split level car without it.

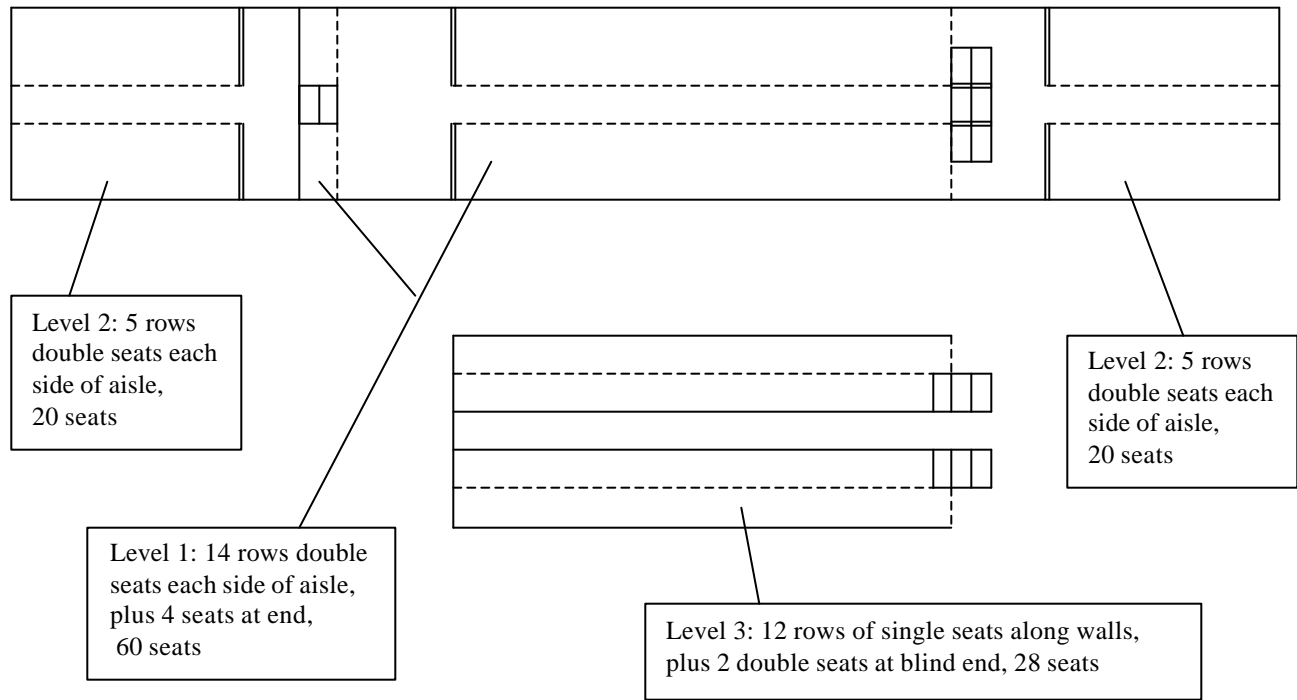
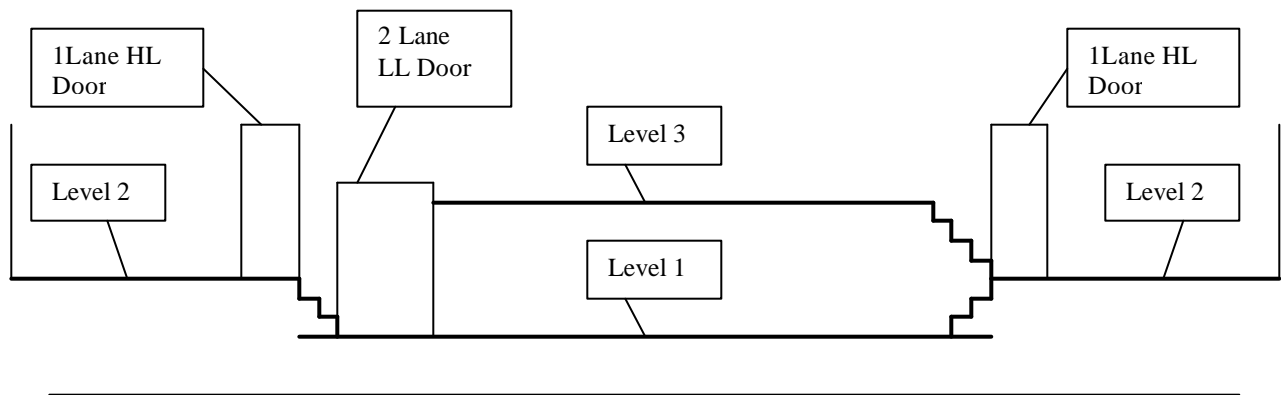
This car body, entranceway, and seating design has the following desirable features—namely, a relatively low roofline, rapid relatively level access at both LL and HL platforms, ADA access at both LL and HL platforms, and substantially increased seating capacity compared to conventional single level cars (which seat about 100). It also provides for structural members below the lower floor—comparable to some current double deck or tri-level cars.

#### 5. References

Brill Debra (2001). *History of the J. G. Brill Company*. Indiana University Press, Bloomington, IN.

Elsner Henry (1997). *The Hedley-Doyle Stepless Streetcar*. N. J. International, Hicksville, NY.

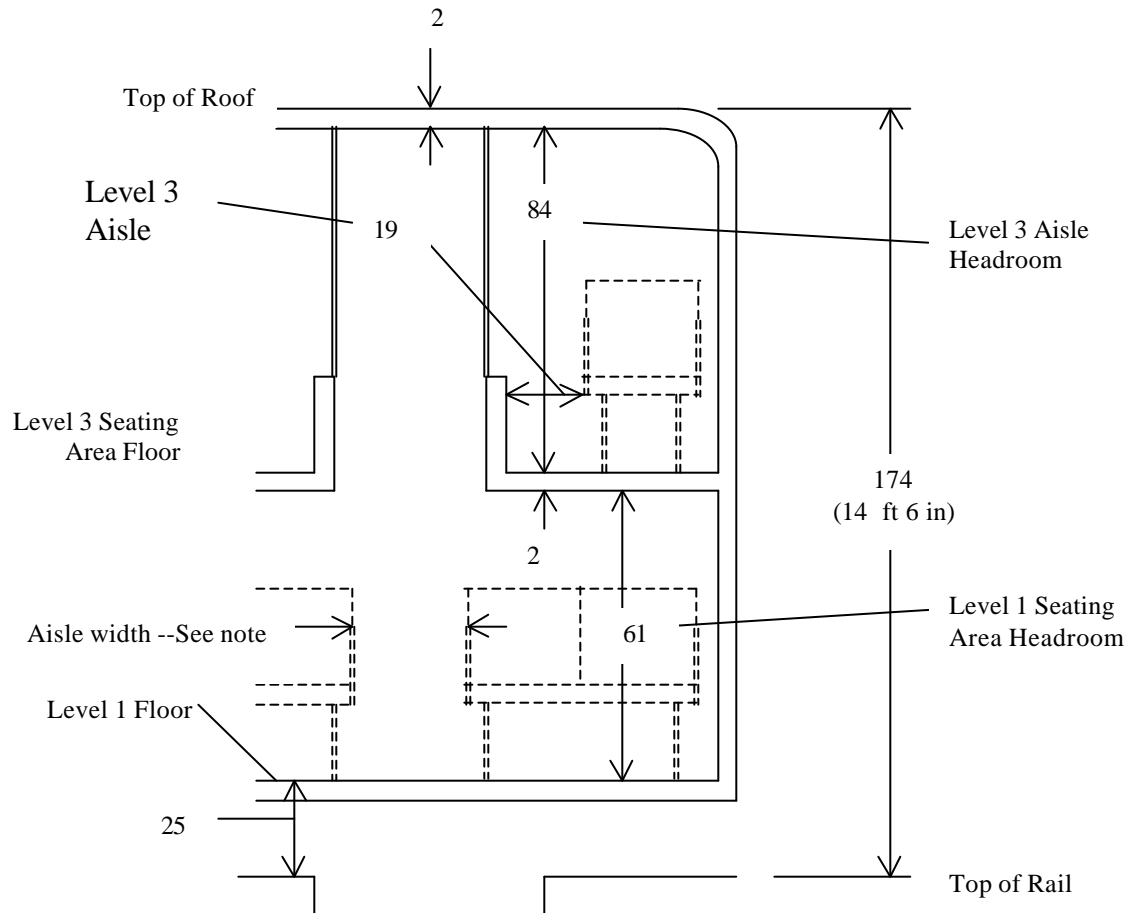
Morlok, Edward K. (2002) Entranceway and Car Body Design: EBD 3.1 - A Three-Level (Double Deck) Railroad Car Body with Full Height Aisles that conforms to Northeastern Clearances. Working Paper, Electrical and Systems Engineering Dept., University of Pennsylvania, Philadelphia, PA.



Notes: 1. All seats face longitudinally along car. End seats in each section face toward center of section.  
 2. See Figure 3 for ADA-compliant variation of this design.

Total seats: 128

Figure 1. EBD 4.1 tri-level railcar body with gallery seating on level 3.



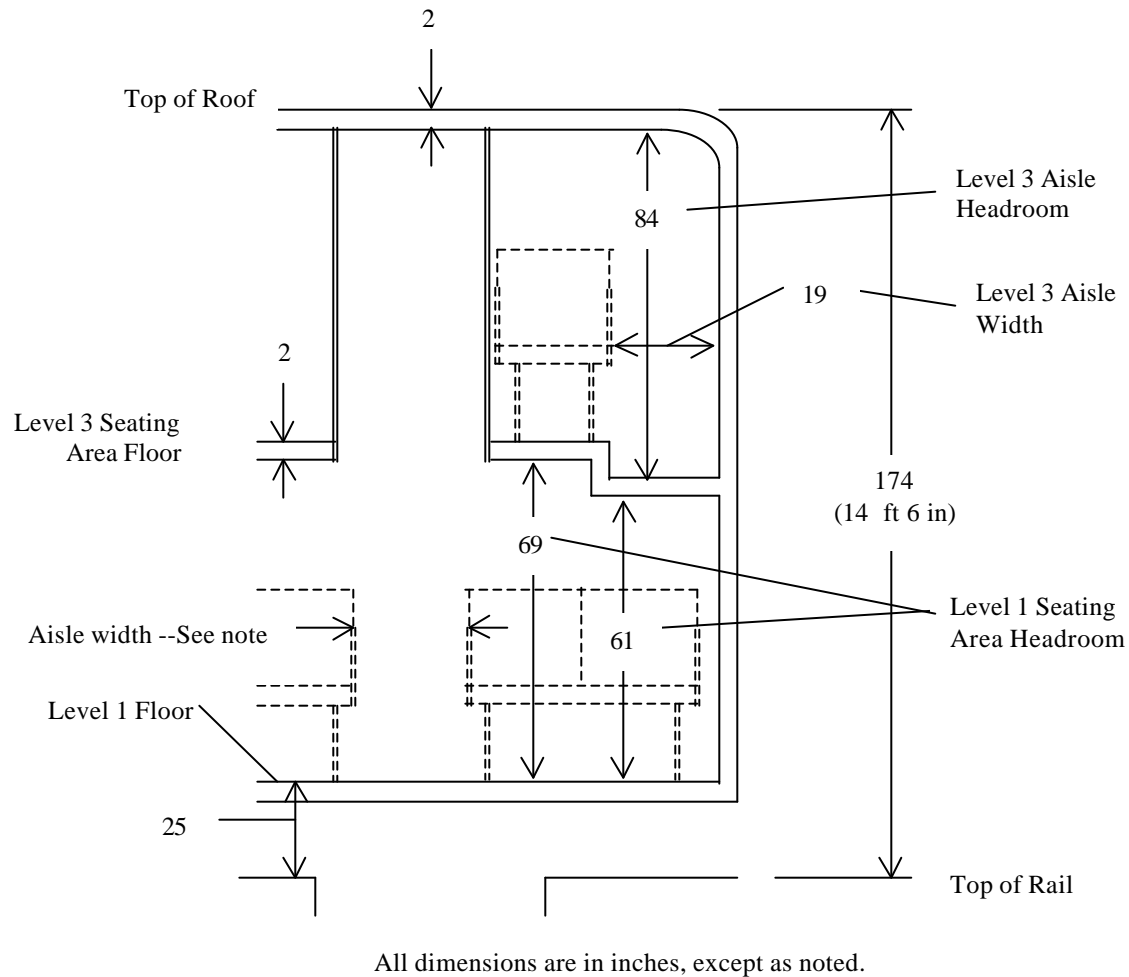
All dimensions are in inches, except as noted.

Notes:

1. Many dimensions can vary. For example, if the level 3 floor is thicker, then the ceiling in level 1 over the seats is correspondingly lowered.
2. Level 1 floor is 25 in above the rail, to permit structural sills underneath it. This is two 8.5 in high steps above a standard location LL platform.
3. Level 1 aisle can be quite wide, e.g., 32 in, if use by wheelchairs is desired. Such use is not essential, since there would be doors for both HL and LL platforms along with a lift between levels 1 and 2 at each end of the car.

a. With gallery (level 3) aisle in usual inside location.

Figure 2. Principle Dimensions of Levels 1 and 3 of EBD 4.1 (continues on next page).



Notes:

4. Many dimensions can vary. For example, if the level 3 floor is thicker, then the ceiling in level 1 over the seats is correspondingly lowered.
5. Level 1 floor is 25 in above the rail, to permit structural sills underneath it. This is two 8.5 in high steps above a standard location LL platform.
6. Level 1 aisle can be quite wide, e.g., 32 in, if use by wheelchairs is desired. Such use is not essential, since there would be doors for both HL and LL platforms along with a lift between levels 1 and 2 at each end of the car.

b. With gallery (level 3) aisle in outside location.

Figure 2. Principle Dimensions of Levels 1 and 3 of EBD 4.1 (continued).

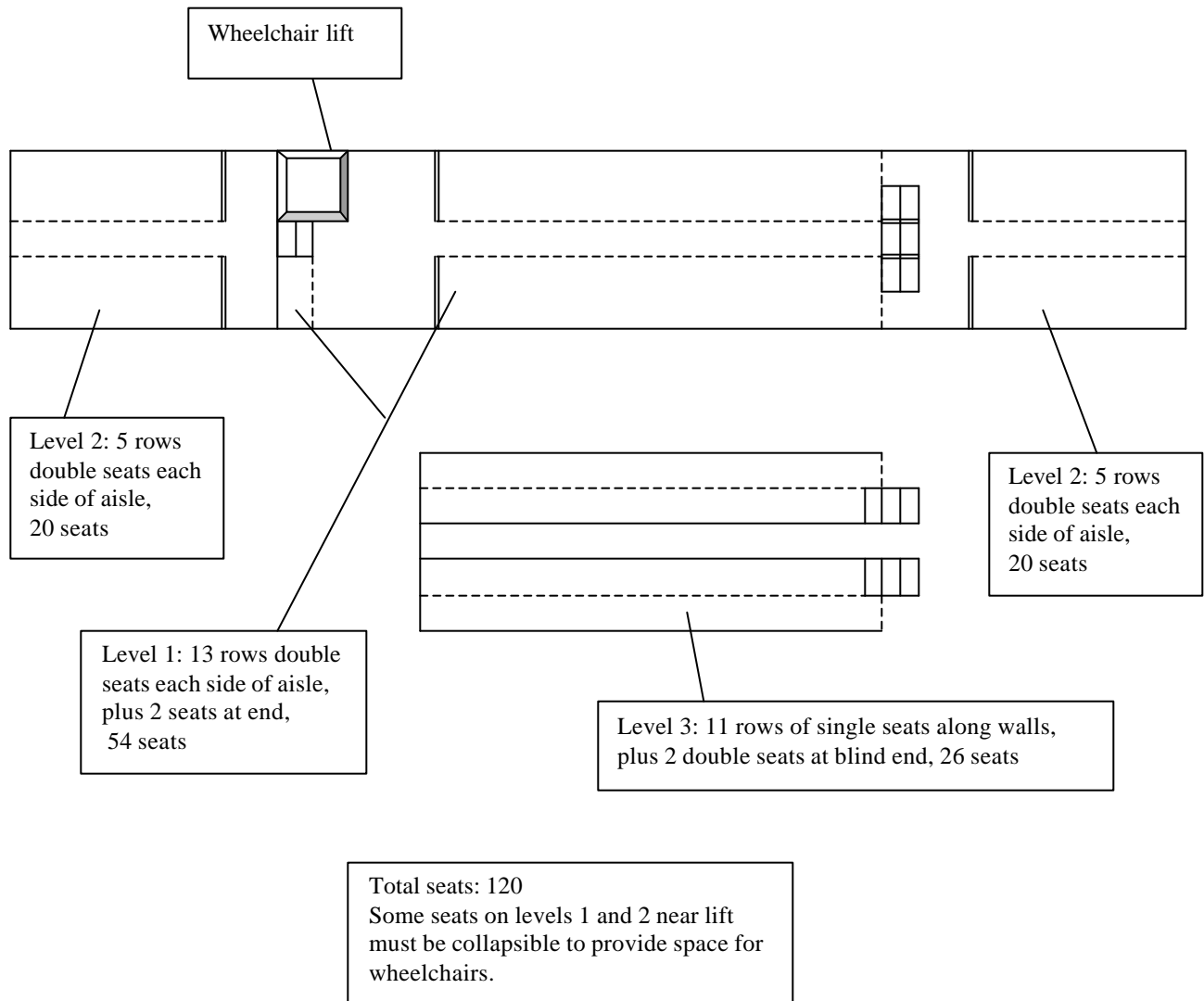
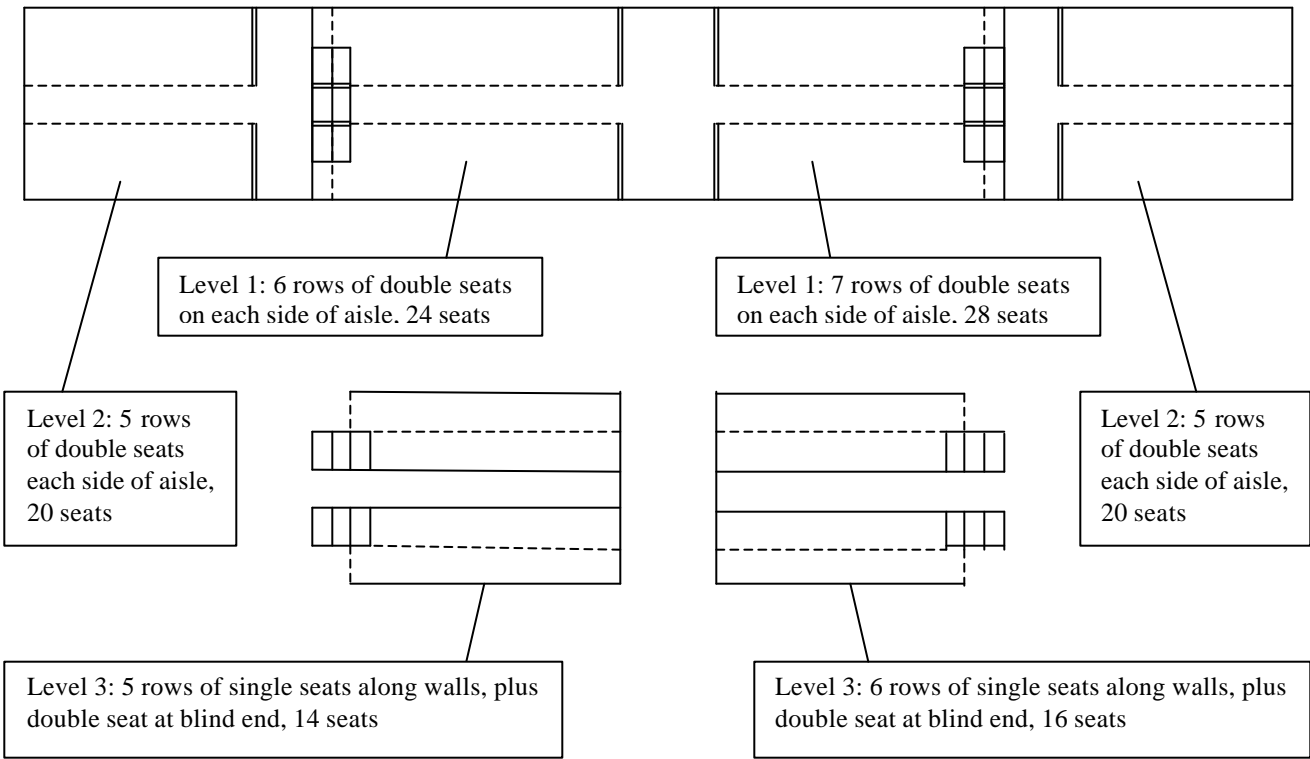
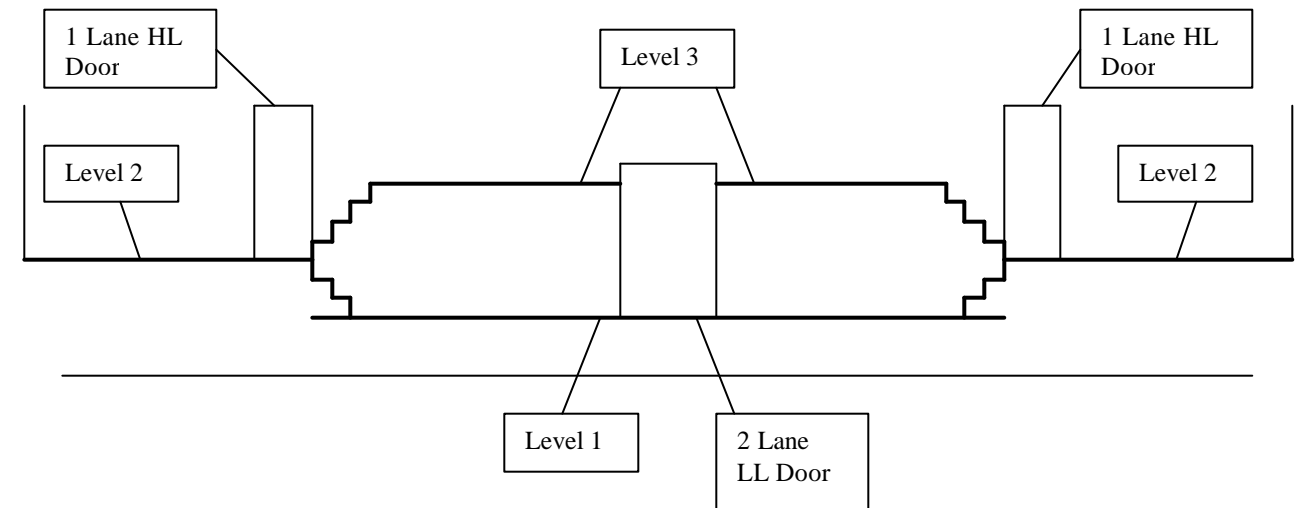


Figure 3. EBD 4.1 tri-level railcar body with ADA compliant features.



Notes: 1. All seats face longitudinally along car. End seats in each section face toward center of section.  
 2. Center door is slightly off-center.  
 3. See Figure 4 for ADA-compliant variation of this design.

Total seats: 122

Figure 4. EBD 4.1 tri-level railcar body with center LL door and gallery seating on level 3.

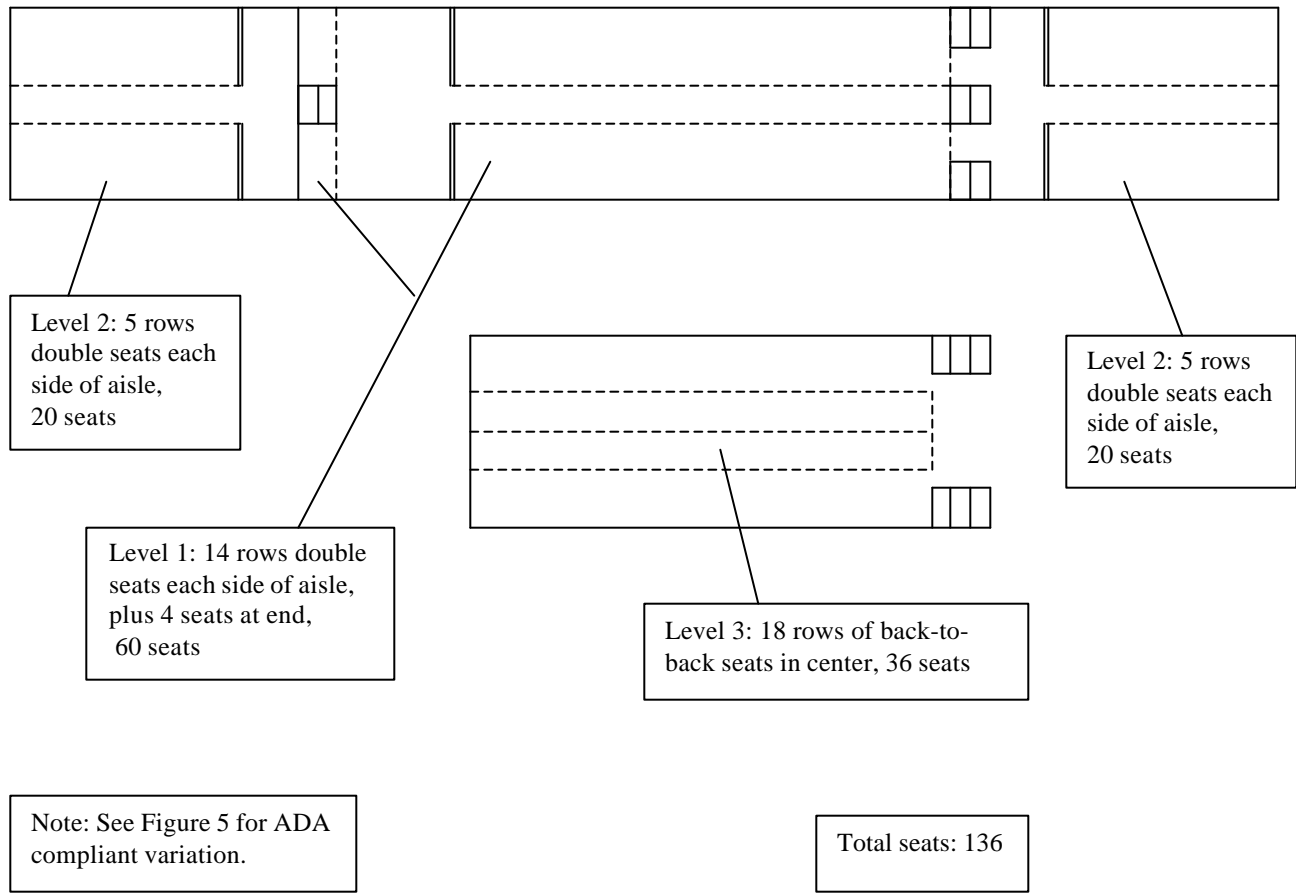
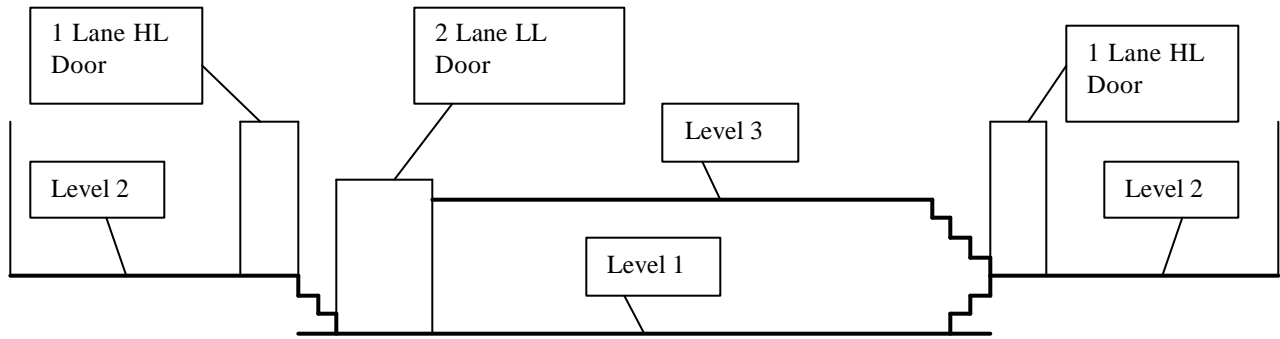
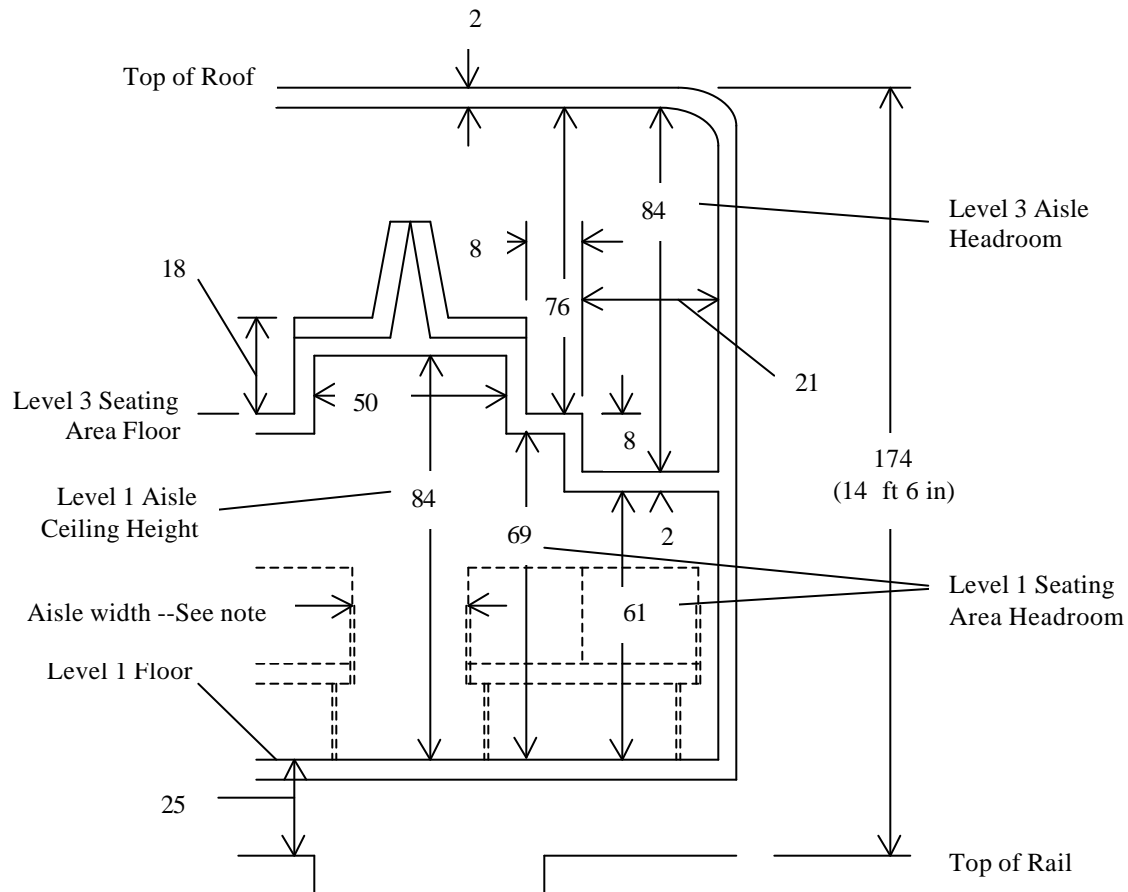


Figure 5. EBD 4.2 tri-level railcar body with Hedley-Doyle (longitudinal) seating on level 3.

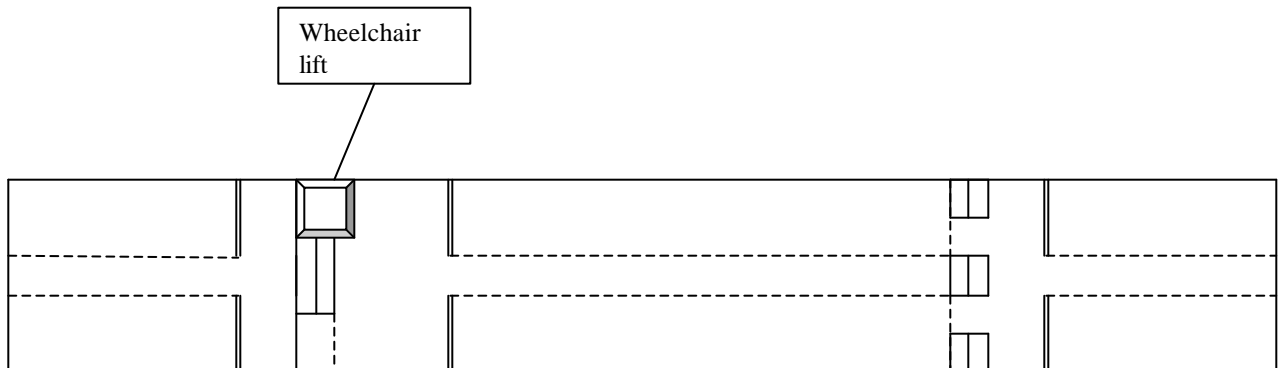


All dimensions are in inches, except as noted.

Notes:

7. Many dimensions can vary. For example, if the car is widened (above standard car floor height) from 10 ft to the now common 10 ft 6 in width, then level 3 is widened. The aisle can be widened to 24 in. If the level 3 floor is thicker, then the ceiling in level 1 over the seats is correspondingly lowered.
8. Level 1 floor is 25 in above the rail, to permit structural sills underneath it. This is two 8.5 in high steps above a standard location LL platform.
9. Level 1 aisle can be quite wide, e.g., 32 in, if use by wheelchairs is desired. Such use is not essential, since there would be doors for both HL and LL platforms along with a lift between levels 1 and 2 at each end of the car.

Figure 6. Principle Dimensions of Levels 1 and 3 of EBD 4.2.



Notes: 1. Addition of wheelchair lift relocates Level 1 doors toward center of car, reducing level 1 and level 3 seating by 1 row each, resulting in the loss of 6 seats. Also one double seat is lost, for a total loss of 8 seats.  
2. Some seats on levels 1 and 2 near the lift must be collapsible to provide space for wheelchairs if needed.

Total seats: 128

Figure 7. EBD 4.2 design with ADA compliant features.