



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: December 21, 2006

In reply refer to: R-06-24 through -27

Honorable Joseph H. Boardman
Administrator
Federal Railroad Administration
1120 Vermont Avenue, N.W.
Washington, D.C. 20590

On Saturday, September 17, 2005, about 8:35 a.m.,¹ eastbound (inbound) Northeast Illinois Regional Commuter Railroad Corporation (Metra) train 504 derailed one locomotive and five cars at milepost (MP) 4.7 near West 47th and South Federal Street in Chicago, Illinois.² The train was being operated in the push mode from a cab control car at the lead end. The train had departed Joliet, Illinois, at 7:24 a.m. en route to the LaSalle Street station in downtown Chicago. The train crew consisted of an engineer in the cab control car and a conductor, an assistant conductor, and a collector in the passenger cars.

The train derailed as it traversed a crossover from track 2 to track 1 that had a prescribed maximum operating speed of 10 mph. The train was traveling 69 mph as it entered the crossover. The second through the fifth cars from the lead end of the train struck a steel girder that was part of a bridge that carried the tracks over 47th Street. Both turnouts of the crossover and one power switch machine were destroyed. Following the accident, Metra relocated the track to a new bridge adjacent to the original bridge.

Metra reported that there were 185 passengers on the train. There were 109 passengers, 4 crewmembers, and 4 others injured. Additionally, two passengers were killed. The derailment occurred during daylight hours, in sunny, clear weather with a temperature of 65° F.³

The National Transportation Safety Board determined that the probable cause of the September 17, 2005, derailment of Metra train 504 in Chicago, Illinois, was the engineer's inattentiveness to signal indications and his failure to operate the train in accordance with the

¹ All times are central daylight time.

² Eastbound trains are inbound trains originating at Joliet, Illinois, destined for the LaSalle Street station in Chicago; conversely, westbound trains are outbound trains departing Chicago. MP numbering decreases in the eastbound, or inbound, direction of travel.

³ For additional information, see National Transportation Safety Board, *Derailed of Northeast Illinois Regional Commuter Railroad Corporation (Metra) Train 504, Chicago, Illinois, September 17, 2005*. Railroad Accident Brief NTSB/RAB-06/07 (Washington, DC: NTSB, 2006).

signal indications and the speed restriction for the crossover at Control Point 48th Street. Contributing to the accident was lack of recognition by Metra of the risk posed by the significant difference between track speed and crossover speed at the accident location and its inaction to reduce that risk through additional operational safety procedures or other means. Also contributing to the accident was the lack of a positive train control system.

As noted above, the train had a recorded speed of 69 mph traveling into the crossover. The excessive train speed and the severe angle of attack between the wheel flanges of the lead set of trucks of the cab control car and the gage corner of the curve closure rail caused the wheels to cross over the railhead and derail. The leading cab control car (8570) derailed first and passed through the 47th Street Bridge⁴ without impact. The second car (7331) derailed and scraped the bridge girder. The third through fifth cars (8548, 7488, and 7351) derailed, struck, and rode over the low girder of the bridge.

The train consisted of cab car 8570 (the operating cab), coach 7331, cab car 8548, coach 7488, coach 7351, and locomotive 409. Cab car 8570 and coach 7351 were not carrying passengers at the time of the accident. The train was operating in the push mode, with cab car 8570 at the lead end and locomotive 409 at the trailing end.

The consist information:

Order	Number	Type	Builder/Date
1	8570	Control Cab	Nippon-Sharyo 2004
2	7331	Coach	Budd 1978
3	8548	Control Cab	Nippon-Sharyo 2004
4	7488	Coach	Amerail 1998
5	7351	Coach	Budd 1980
6	409	Locomotive	MP-36HP3S ⁵ 2003

Metra passenger cars are constructed of stainless steel and are called “gallery cars” because they have two levels. The cars are 85 feet long,⁶ 9 feet 9 inches wide, and 16 feet 3 inches high above the top of the rail. Each car has eight emergency windows for passenger egress (four per level), and another eight emergency windows (four per level) for emergency responder ingress.⁷

⁴ The 47th Street Bridge was a typical highway overhead crossing for the former Chicago, Rock Island and Pacific Railroad built in 1897–98. It was a 70-foot-through girder span, and the top of the girder projected 1.8 feet above the top of the rail.

⁵ Motive Power Incorporated of Boise, Idaho.

⁶ Over the coupler faces.

⁷ Passenger egress windows have signs on the inside of the train telling passengers how to remove the windows; while emergency responder ingress windows have signs on the outside of the train telling responders how to remove the windows.

The area above the center aisle is open and extends to the ceiling of the car with a railing on the side of the upper-level aisle. The 7300-series cars have 46 windows per car, whereas the 7400-series and 8500-series cars have 44 windows per car so the car can accommodate a handicapped restroom. The cars can hold 130 to 157 seated passengers, depending upon the car configuration.⁸

At the center of the car is a vestibule-like area with platform-level doors on either side for entry and exit for a low track-level platform. The vestibule bisects the car; there are two sets of stairs for each half on either side (four stair wells), which lead to an upper-level narrow aisle and seating along the outside for some fixed single seats (some facing toward the center aisle), some with “walkover”⁹ seat backs, and fixed double seats at the bulkheads. The lower level has double seats on either side of the center aisle, most with a walkover seat back, and a few with fixed single seats.¹⁰

Crashworthiness of Seat Backs

The seat cushions have clips that attach, but do not lock, the cushion to the seat frame. The walkover seat backs are not fastened to the seat frame, but slide over two vertical steel bars or pipes connected at the base to a hinge with an inertial latch that is designed to restrain the motion of the seat back at a preset deceleration level and to absorb impact. The seat backs are easily removed from the frame without the use of a tool. The easy separation of the walkover seat backs from the seat frames can create three hazardous conditions:

- The loss of the seat back reduces compartmentalization of passengers during an accident,
- Loose seat backs can be tossed around the passenger compartment during an accident and become projectile hazards, and
- The protruding posts on seat frames can cause sharp-force injuries and present a risk of impalement.

A postaccident inspection of the seats showed that some had sustained extensive damage. For example, car 7488 had 12 seat backs that had separated from their frames (3 of the 12 seat backs had broken frames). Nine seat backs had lifted up and completely separated from the frames, exposing the two vertical posts that held the seat back onto the seat assembly. An inspection of car 7351 showed that 22 seat backs were dislodged, including 1 that had a seat post exposed. In car 8548, four seat backs were dislodged, including one that had completely separated from the seat frame. (See figure 1.)

⁸ The 7300-series cars have seating for 157 passengers; the 7400- and 8500-series cars, when fitted to accommodate three wheel chairs, have seating for 130 and 137 passengers, respectively. Without accommodations for wheel chairs, there is seating for 138 and 146 passengers, respectively.

⁹ Walkover seat backs can be moved across the seat to face either direction of travel.

¹⁰ Some cars (8500-series and car 7488) have single seats on the lower level.



Figure 1. Exposed seat back supports in car 8548.

After the accident, Safety Board investigators mailed a questionnaire to passengers from train 504. Responding to the questionnaire, a passenger who had been in car 7488 stated the following:

All seats tore up and were throwing people from their seats due to detachment. The seats caused a lot of injury it seemed. People were stuck under seats below me on the lower level. [The] seat I was sitting on was torn up and thrown.

Federal Railroad Administration (FRA) regulations state, in 49 *Code of Federal Regulations* (CFR) 238.233(a), that passenger car seats should be securely fastened to the car body such that they can withstand an individually applied acceleration of 8g acting longitudinally, 4g laterally, and 4g vertically. All passenger cars ordered after September 2000 or placed in service after September 2002 are subject to this regulation.¹¹ Dynamic sled testing is one method of testing used to demonstrate compliance with the regulation.¹² In the dynamic testing, the seats are subjected to an 8g-crash pulse in the longitudinal direction.¹³

¹¹ Only two cars on train 504 were placed into service after September 2002: cars 8570 and 8548. Car 7488 was placed into service in 1998.

¹² Compliance may also be shown with static testing or other analysis.

¹³ Title 49 CFR 238.233(a)(2)(ii).

The American Public Transportation Association's (APTA's) *Standard for Row-to-Row Seating in Commuter Rail Cars (SS-C&S-016-99, Rev. 1)* is a voluntary industry standard that states:

The primary objectives of the dynamic sled testing is [sic] to simulate a rail car crash and verify the following:

- That the seat assemblies remain attached to the car,
- That seat components remain attached to the seat assembly,
- That the seat effectively compartmentalizes the occupants, and
- That the seat does an effective job of minimizing human injury.

APTA's standard also states, "Seat components shall not tear loose and become separated from the seat assembly such that the components become projectiles."

Research tests on the walkover seats have shown that the seat backs remain attached during the dynamic test with longitudinal accelerations.¹⁴ However, the vertical and lateral accelerations that occur in a derailment are not adequately represented in the dynamic test. As this accident has shown, the components of the walkover seat can separate from the seat assembly, even in rail cars placed into service after September 2002 (such as car 8548).

The Safety Board concludes that the current design of walkover seats presents an unacceptable risk of injury to passengers during an accident. The FRA regulations already require, and industry standards recommend, that passenger seats be securely fastened to the car body. However, the regulations do not require that other components of the seat assembly, such as seat cushions and seat backs, be securely fastened to the seat. Although some of the passenger cars involved in this accident were put into service prior to the effective date of the current FRA standards, this deficiency should be addressed for all seats, including walkover seats, regardless of the date that they were placed into service. Therefore, to address the cars currently in service, the Safety Board believes that the FRA should immediately require that all passenger car seat backs be secured to the seat assembly. Further, to address cars entering service in the future, the Safety Board believes that the FRA should revise the language in 49 CFR 238.233 to define seat to include all components of the seat assembly, such as seat cushions and seat backs, that could become dislodged when subjected to accelerations specified in that section. The Safety Board also believes the FRA should require all rail passenger car seat assemblies to be dynamically tested to withstand the accelerations specified in 49 CFR 238.233, and require both upward and downward vertical acceleration tests.

Crashworthiness of Car Body Floors

The fourth car (7488) sustained substantial impact damage at its right front corner from striking the bridge girder, and the damage extended rearward for a distance of about 20 feet, resulting in open breaches in that area of the car body. The leading end/lower side-sills of the car

¹⁴ U.S. Department of Transportation, Federal Railroad Administration, *Commuter Rail Seat Testing and Analysis*, DOT/FRA/ORD-01/06 (Washington, DC: FRA, 2001).

were bowed outward about 2 inches and 15 inches on the left and right sides, respectively. Corresponding segments of car body sidewall, directly above the leading end/lower right side-sill, displayed severe sheet metal crushing and displacement/distortion damage, where a 19-foot segment of car body floor¹⁵ had separated and lifted from its supporting structural members. The separated segment of car body floor, at the right front corner, had lifted at least 24 inches,¹⁶ resulting in seat backs located in that area of the car contacting the underside panel of the upper-gallery level. (See figure 2.)



Figure 2. Seat back in front right of car 7488 showing impact dents, the location of which corresponds with the inboard edge of the underside panel of the upper-gallery level (located directly above the seat).

Both passenger fatalities occurred in car 7488; one passenger was pronounced dead on the scene and the other later at the hospital. Both individuals were found in the area where the maximum amount of car body floor lift (24 inches) had occurred. One was found wedged beneath seats and between the folds of deformed metal of the buckled car body sidewall panel. A

¹⁵ The car body lower-level floor is 3/4-inch-thick plymetal comprising 3/4-inch nominal thickness 7-ply BBX Exterior Douglas-fir plywood with a 28 gauge (0.016 inch) #2B finish sheet of grade 304 stainless steel sheathing that is bonded to each side.

¹⁶ Both the third (8548) and fifth (7351) cars received substantial impacts from the bridge girder in several areas resulting in a small amount of vertical lift of the car body's lower-level floor.

segment of 2-inch-diameter pipe hand railing, which had separated from the adjacent bridge walkway, had penetrated the floor at the right rear section of the car in the seat area. A similar length of walkway handrail was embedded in the right front corner of the car.

Federal requirements that address crashworthiness and other safety features of passenger railroad cars used in commuter railroad operations are principally in 49 CFR Part 238, "Passenger Equipment Safety Standards." A review of these standards indicates no requirements relating to the structural (or mechanical) strength or crashworthiness of passenger car body floors.

In 1999, APTA, through a committee consensus process, developed voluntary design standards that include a series of structural standards and recommended practices addressing elements of crashworthiness and other safety features of passenger railroad cars. However, these voluntary design standards have no provisions about the structural or mechanical strength of car body floors of passenger railroad cars.

Before the issuance of APTA's voluntary standards, the Association of American Railroads had a recommended practice in its "Manual of Standards and Recommended Practices, Section A Part III, Passenger Car Requirements."¹⁷ Although this document contained a section titled "Specifications for the Construction of New Passenger Equipment Cars, Standard S-034," which included provisions about the floor supports, it did not establish floor strength requirements or crashworthiness criteria.

In light of the significant injuries and fatalities that resulted from this accident, some of which were apparently related to lack of car body floor integrity, the Safety Board believes that the FRA should establish crashworthiness standards for passenger car body floor structure systems.

Therefore, the National Transportation Safety Board makes the following recommendations to the Federal Railroad Administration:

Immediately require all rail passenger car seat backs be secured to the seat assembly. (R-06-24)

Revise the language in 49 *Code of Federal Regulations* 238.233 to define seat to include all components of the seat assembly, such as seat cushions and seat backs, that could become dislodged when subjected to accelerations specified in that section. (R-06-25)

Require all rail passenger car seat assemblies to be dynamically tested to withstand the accelerations specified in 49 *Code of Federal Regulations* 238.233, and require both upward and downward vertical acceleration tests. (R-06-26)

¹⁷ This document is no longer maintained by this organization.

Establish crashworthiness standards for passenger car body floor structure systems. (R-06-27)

The Safety Board also issued a safety recommendation to the Northeast Illinois Regional Commuter Railroad Corporation (Metra). Please refer to Safety Recommendations R-06-24 through -27 in your reply. If you need additional information, you may call (202) 314-6177.

Chairman ROSENKER, Vice Chairman SUMWALT, and Members HERSMAN and HIGGINS concurred in these recommendations.

[Original Signed]

By: Mark V. Rosenker
Chairman