



**National Transportation Safety Board**  
Office of Railroad, Pipeline and Hazardous Materials Investigations  
Human Performance and Survival Factors Division  
Washington, D.C. 20594

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**Railcar Crashworthiness Group Chairman's Factual Report**  
**August 19, 2015**

**A. Crash Information**

Railroad: Metro-North Railroad  
Train: Passenger Train 659  
Location: Valhalla, New York  
Date: February 3, 2015  
Time: 6:26 pm EST<sup>1</sup>  
Number: DCA15MR006

**B. Group Members**

Dana Sanzo  
National Transportation Safety Board

Pete Lapré  
Federal Railroad Administration

Dwight Sowden  
Metro-North Railroad

David Hess  
Public Transportation Safety Board  
New York State Department of  
Transportation

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<sup>1</sup> Times in this report are Eastern Standard Time.

## **C. Crash Summary**

For a summary of the crash, refer to the *Crash Summary Report* in the docket for this investigation.

## **D. Details of the Investigation**

### **1. Pre-recovery Site Examination**

After the train struck the SUV on the grade crossing, the train and SUV continued to travel north along the track and came to a stop about 665 feet north of the grade crossing. North of the crossing, the third rail runs along the east side of the track. Where a curve in the track begins, the third rail ends on the east side of the track, and it begins on the west side of the track. At this point, there is a downward slope from the track to the ground.<sup>2</sup> The third rail on the west side of the track penetrated through the SUV and into the first car of the train. (See figures 1 and 2.)

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<sup>2</sup> For measurements of the slope, see the *Track & Power Group Chairman's Factual Report*.



Figure 1- A view of the train and SUV looking west



Figure 2- A view of the train and SUV looking southeast

At the front left side of car 4333, a portion of the loop steps was missing, and the third rail was restrained behind the damaged loop step assembly.<sup>3</sup> The rail was trapped between the anti-roll vertical link and the truck assembly. (See figure 3.) The vertical link was twisted, and there was an impact mark on its longitudinal surface. There were scrape marks on the truck side frame top plate. Segments of damaged third rail protection cover were found on top of the truck and the third rail. The vertical link was flame cut to access the third rail to separate SUV from car 4333. After the SUV was removed from the train, a hole was observed in the front right door of the SUV.<sup>4</sup>

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<sup>3</sup> For this report, the west side of the train is the left side, and the east side is the right side.

<sup>4</sup> For further information about the SUV, see the *Survival Factors – Highway Group Chairman’s Factual Report*.



Figure 3- The front left side of car 4333

At the rear of the railcar, there were outward bulges at the end of the car on the right side. (See figure 4.) One segment of the third rail punctured and exited through the top right rear of car 4333 and penetrated into the top right front of car 4332. Inside of car 4332, the third rail was lodged between the exterior carbody shell and the interior ceiling panels.



Figure 4- The third rail between the rear of car 4333 (on the right) and front end of car 4332

On the right side of railcar 4333, a partially melted window was found outside of the car on the ground next to the emergency window near the front of the train. (See figure 5.) An emergency window and a portion of its zip strip with one handle were on the ground outside near the emergency window in the center section of the car.<sup>5</sup> The other center section windows were melted or missing. The rear, right side windows were in place. Pieces of rear emergency door release cover were on the ground near the door. Both side passenger doors passenger side doors were open. There was thick soot on the carbody near window openings.

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<sup>5</sup> A zip strip is a neoprene gasket that holds a window panel in place. For emergency windows, the zip strip has handles that are intended to allow quick removal of the window.



Figure 5- The right side of car 4333

On the left side of railcar 4333, the rear emergency window was on the ground. The zip strip and window gasket were found inside of the car. The second window in the rear section of the car was in place. The remaining windows on the left side of the car were melted or missing. (See figure 6.) The emergency access window from the front side passenger door was outside of the car on the ground. The exterior zip strip was in place in the door. The left side passenger doors could not be opened. There was thick soot on the carbody near window openings.



Figure 6- The left side of car 4333

## 2. Post-recovery Examination of Train 659

In car 4333, the third rail punctured a hole into the exterior subfloor of the car about 8 feet from the front left corner of the car. (See figure 7.) This hole extended into the floor and interior of the car. In the interior of the car, the hole was located under the first row of passenger seats behind the left side electrical locker. At this location, the nose piece of the third rail (a segment about 6 feet long) came to rest between the center hand hold of the second seat row. There was a second puncture in the exterior subfloor of the car located about 18 feet from the front left corner of the car. This hole extended into the floor below the front left vestibule and into the interior of the car under the first row of passenger seats behind the vestibule. Third rail connecting plates and power bonds were found at this entry location.

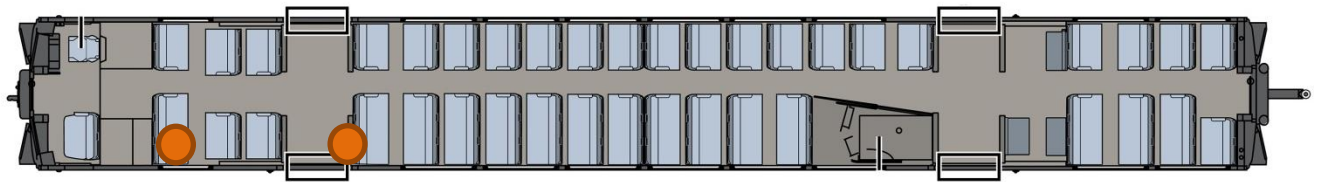


Figure 7- A plan view of car 4333 with the front of the car at the left. The two circles show the locations where the third rail entered the car.

There were 11 sections of third rail inside of the car.<sup>6</sup> (See figures 8 and 9.) Throughout the car, there was extensive fire damage.<sup>7</sup> In the center section of the car, the left side center section seat frames and backs were bent toward the rear of the car. (See Attachment 1 for further information.) The right side seat frames were generally secure in position. There was no baggage racks mounted on the side walls in the center section of the car. Sections of broken baggage rack were found throughout the car. At the rear of the car, one section of the third rail was on the floor about one foot from the rear door.



Figure 8- A view toward the rear of the interior of car 4333

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<sup>6</sup> For further information about the third rail, see the *Track & Power Group Chairman's Factual Report*.

<sup>7</sup> For further information about the fire investigation, see the *Fire Group Factual Report*.



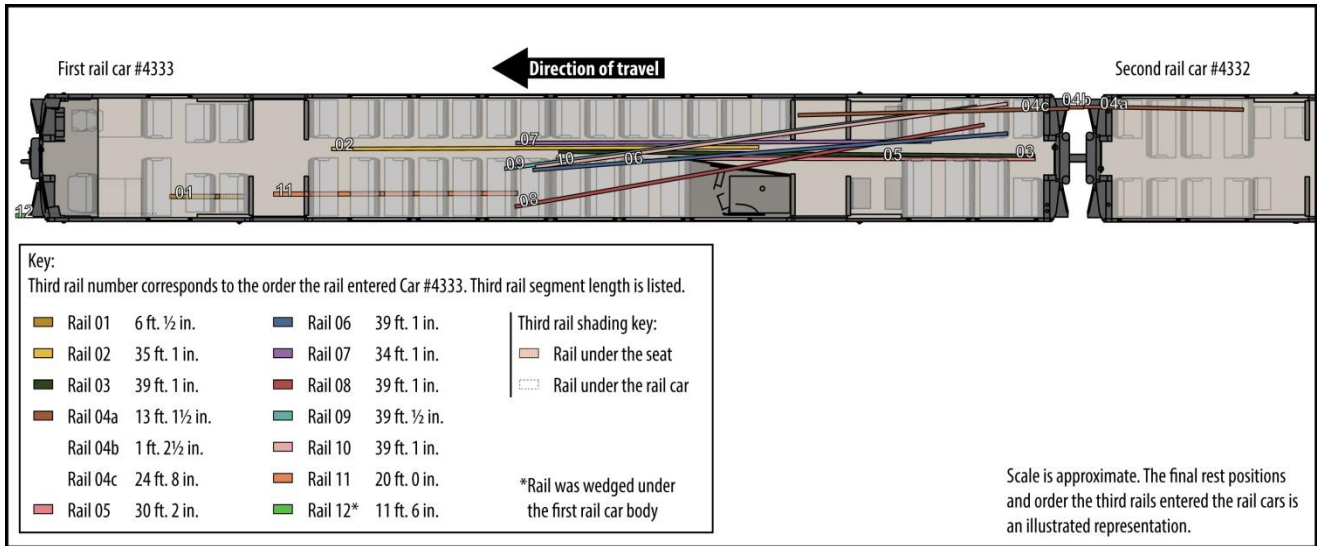


Figure 9-The approximate positions of the third rail located inside of car 4333

At the front left side corner of the car, the carbon steel underframe structure and pneumatic piping were discolored, the stainless steel skin was discolored and warped, and the horn was separated from its mounting plate. (See figure 10.)



Figure 10- The front left corner of car 4333<sup>8</sup>

As previously noted, in car 4332, there was a section of third rail lodged between the exterior carbody shell and the interior ceiling panels. With this exception, the rear seven passenger cars were structurally intact. The condition of the emergency exits for these seven cars was documented. In car 4332, three emergency windows and three passenger side doors were open. In car 4197, the four passenger side doors and emergency windows were open. In car 4196, one emergency window was partially open, and the four passenger side doors were open. In cars 4175 and 4175, one emergency window was open, and three passenger side doors were open in each car. In car 4309, one passenger side door was open. In car 4308, three passenger side doors were open. During the examination of these cars, zip strips for the emergency windows were noted to have tears near the handle connection. The zip strips were submitted to the NTSB's materials laboratory for examination, and that report available is in the public docket.

### 3. Train 659

Train 659 consisted of eight Bombardier M-7 passenger cars. M-7 cars are configured to operate in married pairs. The cars have a full-width operator's cab at the F-end of each car. The opposite ends of the cars are designated the B-end.

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<sup>8</sup> The white globe in the picture is a component used for 3D laser scanning.

<b>Position in Consist</b>	<b>Car Number</b>	<b>Acceptance Date</b>
1	4333	July 11, 2006
2	4332	July 11, 2006
3	4197	June 30, 2005
4	4196	June 30, 2005
5	4175	February 18, 2005
6	4174	February 18, 2005
7	4309	June 15, 2006
8	4308	June 15, 2006

Table 1-Acceptance dates for the passenger cars in train 659

#### **4. M-7 Passenger Car Specifications**

All cars in the consist were Bombardier M-7 passenger cars. The length of the cars is 85 feet, and the width is 10 feet 6 inches. M-7 cars are configured to operate in married pairs, and one of the pair has an ADA compliant bathroom. Each rail car has a prybar, a dry chemical fire extinguisher, and an emergency ladder.

The cab end of the car is sheathed under a fiberglass end cap with stainless steel of strength equivalent to 2-inch thick steel with a yield strength of 26,000 psi. The mechanical coupler is a Wabco N-6-A coupler. (See figure 11.) The diameter of the pin is about 3 inches. The coupler height is about 34 inches above top of rail to the centerline of the coupler. Buffer face plates are held against the face plate of a coupled car by a side stem and compression spring. There is a snowplow and pilot assembly at the cab end of the car. The snowplow is "V" shaped to direct snow over the third rail. According to the specification, the pilot should protect all of the equipment at the end of the cars to the extent possible. The maximum width of the assembly is about 59 inches.



Figure 11- A side view of the cab end of car 4332.

The exterior of the carbody is stainless steel. The cars have two side passenger side doors on each side of the car and an end door at each end of the car. The doors are stainless steel with a stainless steel honeycomb core. The carbody openings for the side doors are reinforced by the end sill, roof rail, and vertical frames. The side doors are a single sliding leaf with an interior emergency release. The side door windows are specified to be used as emergency access and egress with a minimum clear opening of 18 inches by 24 inches. The door window has interior and exterior zip strips. The end doors are centered between the collision posts and are hinged to swing inward.

Loop steps are located at each corner of the car body and below each side door. The lower step is specified to no more than 18 inches above top of rail. There is a vertical handhold above each side door loop step. Horizontal handholds are located above the loop step at each corner of the car and at the bottom edge of each end of the car.

The windows are specified to meet the glazing requirements for 49 CFR 223 for end and side facing windows. They are specified to be capable of withstanding pressure differentials caused by head-on pressures and passing trains at a passing speed of 100 mph. The windshields are 0.563 inch safety glass, and the side windows and door windows are 0.460 inch polycarbonate. The side windows are a single pane surrounded by a neoprene gasket. This assembly is mounted in an aluminum frame with an aluminum compression ring. The windows

are designed to be removed from inside of the car. The window escape opening is about 53 inches by 24 inches.

For emergency windows, each small window has one red handle, and each large window has two red handles. As specified, the handle is attached to the zip strip with a wire rod. The handles are covered with a photo-luminescent background. The force to remove the zip strip is specified as a maximum of 40 pounds. According to the specification, signage showing the location of emergency exits and instructions on their operation shall be provided in each car per FRA Emergency Order No. 20, or replacement regulation. Interior signage is specified as a photoluminescent material; exterior signage is specified as retro-reflective.

The car floor is framed with side sills and cross beams, and this frame supports the floor panels and the underfloor equipment units. The floor pans are specified to be stainless steel not less than 0.020 inch thick. The pans are joined to the floor beams and side sills. The floors are constructed of 0.75 inch thick plymetal with 0.016 inch thick stainless steel outer layers. The floor covering material is rubber with a thickness of 0.14 inches. The distance between the top of rail to the top of the finished floor is 51 inches.

Each side of the car has a two or three person seat. (See figure 12.) The distance between the front of a backrest cushion and the back of the next seat back is about 30 inches. The distance between the backrest cushions of facing seats is about 48 inches. The seat frame backrest is about 17 degrees angle. The right side seats have grab handles on the aisle side of the seat pair. The handles are a stainless steel casting with a nickel-plated satin finish. The handle and its attachment are specified to withstand a 500-pound longitudinal force without permanent deformation or separation. Headrest handles are made from nickel-plated aluminum with the same strength requirements for the aisle grab handles.

The luggage racks are constructed with a front and back rail with round transverse rails between the front and back rails. The luggage racks are specified to the strength to resist loads due resulting from accelerations (8g longitudinal direction and 4g lateral and vertical directions) acting on a representative luggage weight of 25 pounds per foot.



Figure 12- A view of the interior of car 4197 looking toward the rear of the car

## 5. Measurements from 3-D Laser Scans

In the days following the crash, 3-D laser scanning was conducted for car 4333, an exemplar car (car 4021), the SUV, and the grade crossing. The *3D Laser Scanning On-scene Factual Report* documents the methods used to conduct the 3-D laser scans. The following figures show images and dimensions measured from the laser scans.

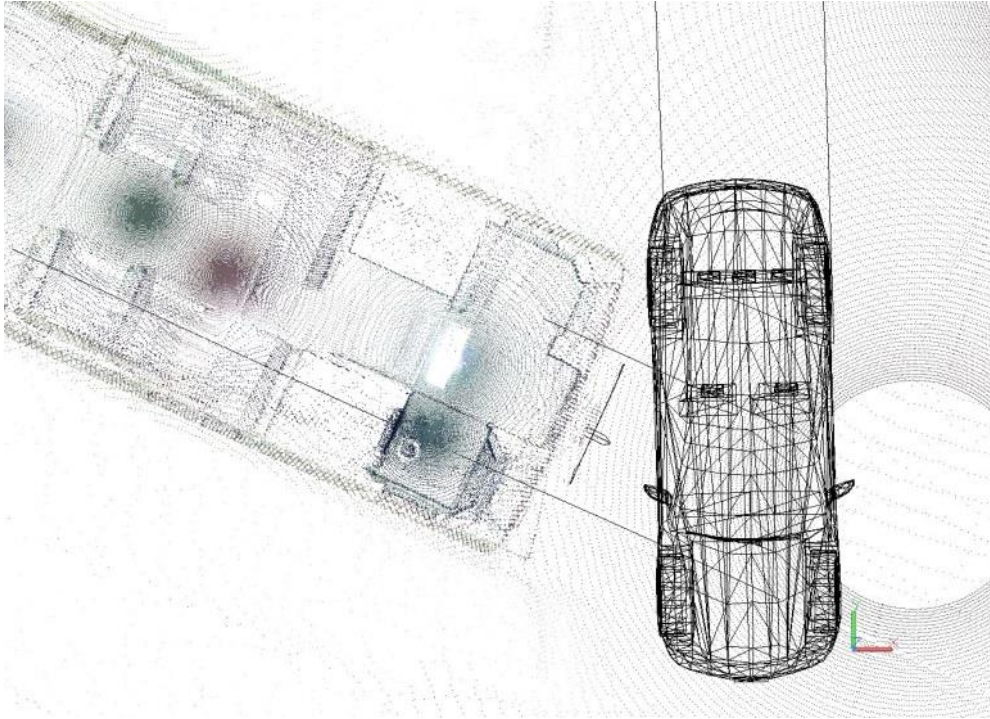


Figure 13- The estimated pre-impact position of the SUV relative to car 4333 based on the coupler alignment pin on the railcar and the hole in the SUV's door

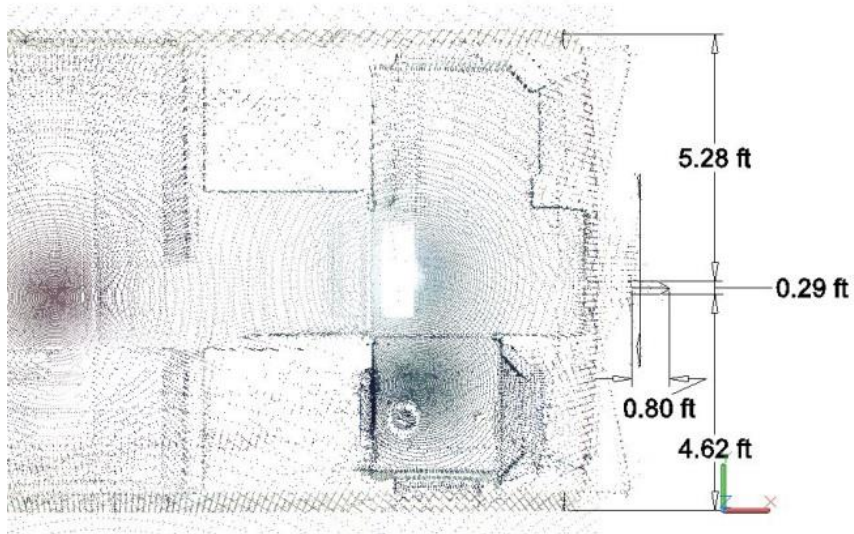


Figure 14- An overhead view showing the position, length, and diameter of the coupler alignment pin based on the 3D laser scan of an exemplar railcar 4021



Figure 15- A side view showing the height of the coupler above the ground taken from the 3D laser scan of an exemplar car 4021

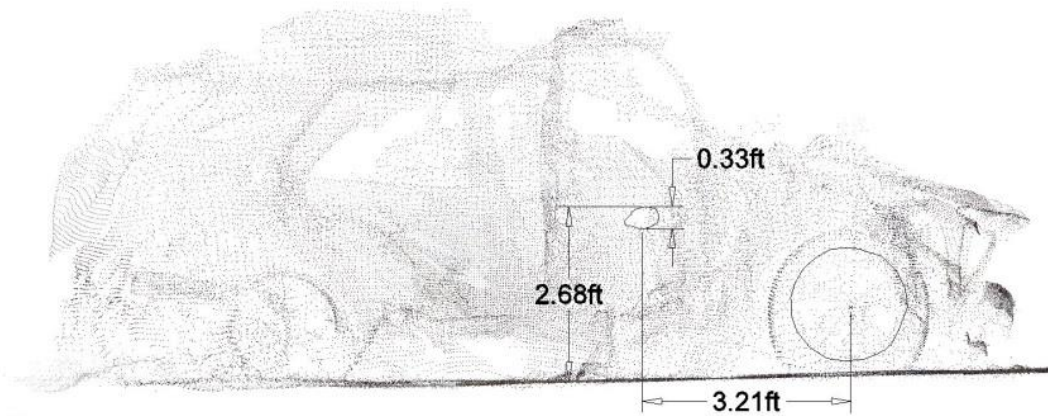


Figure 16- A side view showing the size and position of the puncture hole on the front, passenger door of the crash-involved SUV based on the 3D laser scan

-- End of report --



## **Attachment 1**

The following table lists seat frame damage. For this table, seat rows are numbered starting at the F-end of the car; the flip-up seats are not numbered. For direction descriptions, “forward” is in the direction of the F-end of the car, and “rearward” is in the direction of the B-end of the car.

L1	Section of armrest missing		R1
L2	Section of armrest missing		R2
L3			R3
Vestibule			Vestibule
L4			R4
L5	Most of frame removed Remaining frame at the sidewall bent rearward	Section of armrest missing Aisle hand hold not present	R5
L6	Most of frame removed Remaining frame at the sidewall bent rearward	Aisle hand hold not present	R6
L7	Most of frame removed Remaining frame at the sidewall bent rearward	Aisle hand hold not present	R7
L8	Severe rearward bending	Aisle hand hold not present Section of armrest missing	R8
L9	Severe rearward frame bending	Aisle hand hold not present	R9
L10	Severe rearward frame bending	Headrest forward bending Aisle hand hold not present	R10
L11	Rearward frame bending	Aisle hand hold not present	R11
L12	Rearward frame bending Headrest rearward bending	Headrest rearward bending Aisle hand hold not present	R12
L13	Third rail section next to headrest Headrest rearward bending	Aisle hand hold not present Headrest rearward bending	R13
L14		Aisle hand hold not present	R14
		Aisle hand hold not present Headrest rearward bending	R15
Bathroom		Aisle hand hold not present Section of third rail next to headrest	R16
		Could not fully visualize	R17
Vestibule			Vestibule
L16		Aisle handhold present	R19
L17		Aisle handhold present	R20
L18		Two impact marks above the seat	R21

Table 2- A description of seat frame damage in car 4333.

## **Attachment 2**

The following table lists the condition of the emergency exits for the rear seven passenger cars. During the examination of these cars, zip strips for the emergency windows were found with tears near the handle connection. The zip strips were submitted to the NTSB's materials laboratory for examination, and that report is available in the public docket.

Car number	R1 Window	R6 Window	L3 Window	L7/L8 Window	R1 Door	R2 Door	L1 Door	L2 Door
4332	Fully open	Fully open		Fully open	Release handle pulled – door open	Release handle pulled – door open	Release handle pulled – door open	
4197	Fully open	Fully open	Fully open	Fully open	Release handle pulled – door open	Release handle pulled – door open	Release handle pulled – door open	Release handle pulled – door open
4196				Partially opened	Release handle pulled – door open	Release handle pulled – door open	Release handle pulled – door open	Release handle pulled – door open
4175			Fully open			Release handle pulled – door open	Release handle pulled – door open	Release handle pulled – door open
4174				Fully open	Release handle pulled – door open	Release handle pulled – door open	Release handle pulled – door open	
4309							Release handle pulled – door open	
4308					Release handle pulled – door open	Release handle pulled – door open	Release handle pulled – door open	

Table 3-A description of the emergency exits for the rear seven passenger cars.