# Highway-Railroad Grade Crossing Collision
# Commerce Street
# Valhalla, New York
# February 3, 2015


**Accident Report**

NTSB/RAR-17/01
PB2017-102658

**National Transportation Safety Board**

NTSB/RAR-17/01
PB2017-102658
Notation 56754
Adopted July 25, 2017

# Railroad Accident Report

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**National Transportation Safety Board**

490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

**National Transportation Safety Board. 2017.** ***Highway-Railroad Grade Crossing Collision, Commerce Street, Valhalla, New York, February 3, 2015*****. Railroad Accident Report NTSB/RAR-17/01. Washington, DC.**

**Abstract:** On February 3, 2015, at 6:26 p.m., a vehicle driven by a 49-year-old woman, traveled northwest on Commerce Street in Valhalla, New York, toward a highway-railroad grade crossing. The driver entered the boundary of the grade crossing and stopped. The driver then moved beyond the boundary and stopped adjacent to the railroad tracks. The grade crossing warning system activated and the gate came down, striking the rear of the vehicle. She exited her vehicle, examined the gate, then returned to her vehicle and moved forward on to the tracks. Meanwhile, a Metro-North Railroad train approached the grade crossing. The engineer activated the emergency brakes and collided with the vehicle at 51 mph. The train and the vehicle continued north, damaging the electrified third rail which pierced the vehicle and penetrated the lead railcar. Five passengers died and nine passengers and the engineer were injured, all in the lead railcar. The driver of the vehicle also died. The NTSB made new recommendations to the Federal Transit Administration; Metro-North; Long Island Rail Road, Amtrak, Port Authority Trans-Hudson Corporation, and Southeastern Pennsylvania Transportation Authority; the New York Department of Transportation, and the town of Mount Pleasant, New York.

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# Contents

# Figures

# Tables

# Abbreviations and Acronyms

| | |
|---|---|
| **AC** | alternating current |
| **Amtrak** | National Railroad Passenger Corporation |
| **CAMI** | Civil Aerospace Medical Institute |
| ***CFR*** | *Code of Federal Regulations* |
| **dB** | decibels |
| **DC** | direct current |
| **DES** | Department of Emergency Services |
| **DOT** | US Department of Transportation |
| **ECC** | emergency communications center |
| **EMS** | emergency medical services |
| **FAA** | Federal Aviation Administration |
| **FHWA** | Federal Highway Administration |
| **FRA** | Federal Railroad Administration |
| **FTA** | Federal Transit Administration |
| **GCT** | Grand Central Terminal |
| **GPS** | global positioning device |
| **GIS** | geographic information system |
| **grade crossing** | highway-railroad grade crossing |
| **IC** | incident command |
| **LED** | light emitting diode |
| **LIRR** | Long Island Rail Road |
| **Metro-North** | Metro-North Railroad |

| | |
|---|---|
| **mph** | miles per hour |
| **MTA** | Metropolitan Transportation Authority |
| **MTAPD** | Metropolitan Transportation Authority Police Department |
| **MUTCD** | *Manual on Uniform Traffic Control Devices* |
| **NHTSA** | National Highway Traffic Safety Administration |
| **NYDMV** | state of New York Department of Motor Vehicles |
| **NYS MUTCD** | New York State supplement to *Manual on Uniform Traffic Control Devices* |
| **NTSB** | National Transportation Safety Board |
| **NYSDOT** | state of New York Department of Transportation |
| **ODI** | Office of Defect Investigation |
| **ODOT** | state of Ohio Department of Transportation |
| **PATH** | Port Authority Trans-Hudson Corporation |
| **POC** | point of collision |
| **SCADA** | supervisory control and data acquisition |
| **SEAR II** | Safetran Event Analyzer Recorder II |
| **SEPTA** | Southeastern Pennsylvania Transportation Authority |
| **SUV** | sport-utility vehicle |
| **TDOT** | state of Texas Department of Transportation |
| **UDOT** | state of Utah Department of Transportation |
| **VVFD** | Valhalla Volunteer Fire Department |
| **WMC** | Westchester Medical Center |

# Executive Summary

On February 3, 2015, at 6:26 p.m. eastern standard time, a 2011 Mercedes Benz ML350 sport-utility vehicle driven by a 49-year-old woman, traveled northwest on Commerce Street in Valhalla, New York, toward a public highway-railroad grade crossing on the Harlem Subdivision of the Metro-North Railroad. Traffic on Commerce Street was heavy and congested when the driver turned northeast and entered the boundary of the highway-railroad grade crossing and stopped.[1] The highway-railroad grade crossing consisted of two highway lanes (one for each direction) and two railroad tracks, and was equipped with reflectorized pavement markings, advance warning signs, flashing lights, and gates. The driver moved beyond the highway-railroad grade crossing boundary (stop line) and stopped adjacent to the railroad tracks. The grade crossing warning system activated and the gate came down, striking the rear of her vehicle. She then exited her vehicle and examined the gate. The driver then returned to her vehicle and moved forward on to the tracks. Meanwhile, Metro-North Railroad passenger train 659, consisting of eight passenger railcars, traveled north and approached the highway-railroad grade crossing at a speed of 59 miles per hour. The engineer from train 659 activated the train's emergency brakes about 260 feet before the highway-railroad grade crossing and collided with the sport-utility vehicle at a recorded speed of 51 miles per hour.

The train and the sport-utility vehicle continued northbound, resulting in the damage of the electrified third rail on the west side of the track. The third rail detached, pierced the sport-utility vehicle, and then entered the railcar. The train and the sport-utility vehicle came to rest about 665 feet from the point of collision. An estimated 343 feet of third rail penetrated the first passenger railcar.

Metro-North Railroad estimated 645 passengers were onboard train 659 at the time of the accident. Five passengers died and nine passengers and the engineer were injured, all in the lead railcar. The driver of the sport-utility vehicle also died.

This report addresses the following safety issues:

- **Metro-North Railroad third rail design.** Metro-North Railroad's third rail system was not constructed to fail in a controlled manner or break away.[2] The National Transportation Safety Board found that Metro-North Railroad's third rail system was not constructed to break away when subjected to undesirable overloaded conditions such as those involved in this accident.

- **Grade crossings.** There were three grade crossings within 2 miles of the Commerce Street grade crossing. The state of New York Department of Transportation has a policy that allows for the consolidation of grade crossings wherever possible. The National

[1] In this report, the term *boundary* is used for the reader to conceptualize the location of the sport-utility vehicle past the stop line of the highway-railroad grade crossing. This stop line indicates the point behind which highway vehicles are stopped or might be required to stop when the grade crossing warning system activates.

[2] *Third rail* refers to a conducting rail by which electric traction power is delivered to trains. On this system, as with most systems, the conductor rail is placed on the outside of the running rails.

Transportation Safety Board determined that the town of Mount Pleasant, New York, should take action to improve grade crossing safety.

- **Grade crossing risk assessment.** The investigation found that the proximity of highway-railroad grade crossings with third rail systems belonging to commuter railroads or rail transit properties could increase the severity of highway-railroad grade crossing accidents. The National Transportation Safety Board found that conducting a risk assessment of such conditions could help mitigate this increased risk of grade crossing accident severity.

The National Transportation Safety Board determines that the probable cause of the accident was the driver of the sport-utility vehicle, for undetermined reasons, moving the vehicle on to the tracks while the Commerce Street highway-railroad grade crossing warning system was activated, into the path of Metro-North Railroad train 659. Contributing to the accident was the driver of the sport-utility vehicle: (1) stopping beyond the stop line, within the boundary of the highway-railroad grade crossing, despite warning signs indicating the approach to the grade crossing; and (2) reducing the available time to clear the grade crossing by exiting the vehicle after the grade crossing warning system activated because the driver's attention was diverted by the grade crossing warning system crossing gate arm striking her vehicle. Contributing to the severity of the accident was the third rail penetrating the passenger compartment of the lead passenger railcar and the postaccident fire.

# 1. Factual Information

## 1.1 Accident Narrative

On February 3, 2015, at 6:26 p.m. eastern standard time, a 2011 Mercedes Benz ML350 sport-utility vehicle (SUV) driven by a 49-year-old woman (driver), traveled northwest on Commerce Street in Valhalla, New York, toward a public highway-railroad grade crossing (US Department of Transportation [DOT] crossing 529-902V) on the Harlem Subdivision (Line) of the Metro-North Railroad (Metro-North).[1] Traffic on Commerce Street was heavy and congested when the driver turned northeast and entered the boundary of the highway-railroad grade crossing (grade crossing) and stopped.[2] The grade crossing consisted of two highway lanes (one for each direction) and two railroad tracks, and was equipped with reflectorized pavement markings, advance warning signs, flashing lights, and gates. The driver moved beyond the grade crossing boundary (stop line) and stopped adjacent to the railroad tracks. The grade crossing warning system activated and the gate came down, striking the rear of her vehicle. She then exited her vehicle and examined the gate. The driver then returned to her vehicle and moved forward on to the tracks. Meanwhile, Metro-North passenger train 659, consisting of eight passenger railcars, traveled north and approached the grade crossing at a speed of 59 miles per hour (mph). The engineer from train 659 activated the train's emergency brakes about 260 feet before the grade crossing and collided with the SUV at a recorded speed of 51 mph. (See figure 1.)

[1] (a) All times in the report are eastern standard time; (b) although the general direction of the road is northwest, the road jogged northeast to cross the tracks.

[2] In this report, the term *boundary* is used for the reader to conceptualize the location of the SUV past the stop line of the grade crossing. This stop line indicates the point behind which highway vehicles are stopped or might be required to stop when the grade crossing warning system activates.


**Figure 1.** Metro-North train 659 on track 2 after collision with the SUV.

Metro-North train 659 was traveling north on track 2 toward the Commerce Street grade crossing when it struck the SUV on its passenger side door and pushed it about 665 feet north on the tracks before stopping. During the collision, the electrified third rail first pierced the SUV on its left side under the rear passenger seats, then pierced its fuel tank, and subsequently exited the SUV on the right side, below the frame and behind the right-side rear wheel. As the train and SUV continued to move, the rail was shoved under the left-side front portion of the lead railcar, and subsequently penetrated it from the underside in two locations near the left-side front passenger doorway. (See figure 2.)

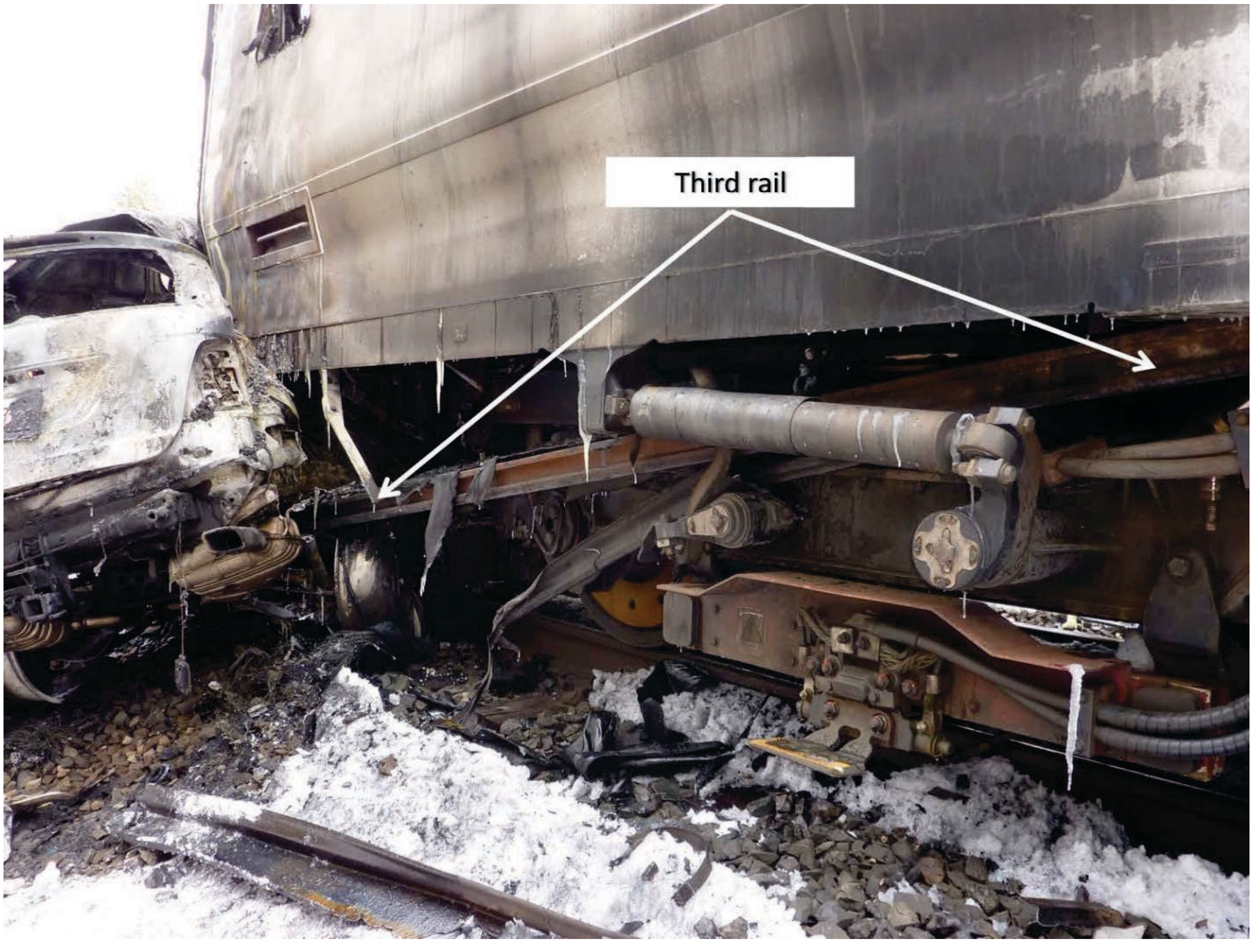


**Figure 2.** Photograph of the SUV and Metro-North train 659 after the collision.

An estimated 386 feet of third rail was damaged, including 11 sections totaling about 343 feet that penetrated the passenger compartment of the lead railcar. A fire ignited that consumed both the SUV and the interior compartment of the lead railcar. (See figure 3.)

**Figure 3.** Postaccident photograph of the interior of the lead railcar.

Metro-North estimated that train 659 carried 645 passengers at the time of the accident. Five passengers died and nine passengers and the engineer were injured on the train; all of whom were riding in the lead railcar. The driver of the SUV also died. The temperature at the time of the accident was 20°F, it was dark with no precipitation. The area of Commerce Street near the grade crossing was clear and recently plowed of snow.

## 1.2 Factors Associated with the SUV

### 1.2.1 Accident Trip

According to the driver's spouse (spouse), the driver was traveling to Scarsdale, New York, to meet a business client at a coffee shop.[3] The driver was the sole occupant of the SUV at the time of the accident. In an interview, the spouse said the driver was unfamiliar with the accident location. The driver would have traveled south on Taconic State Parkway, about 8 miles from the intersection with Commerce Street, to reach the destination.

[3] The location of the coffee shop was determined to be 51 East Parkway, Scarsdale, New York.

The driver likely had been detoured on to Commerce Street because of an automobile crash that occurred at the intersection of Taconic State Parkway and Lakeview Avenue at 5:25 p.m. on the day of the accident. (See figure 4.) Lakeview Avenue is located about 0.4-mile southeast of the intersection of Commerce Street and Taconic State Parkway. The earlier crash was in the process of being cleared and the right southbound lane of Taconic State Parkway was being detoured on to Lakeview Avenue.[4]

After the detour, the driver traveled northwest on Commerce Street toward the grade crossing, back to the intersection of Commerce Street and Taconic State Parkway. To reach Scarsdale, the driver would again have had to turn southeast on to the Taconic State Parkway and choose the left lane to avoid the detour, located in the southbound lanes at the intersection of Taconic State Parkway and Lakeview Avenue.

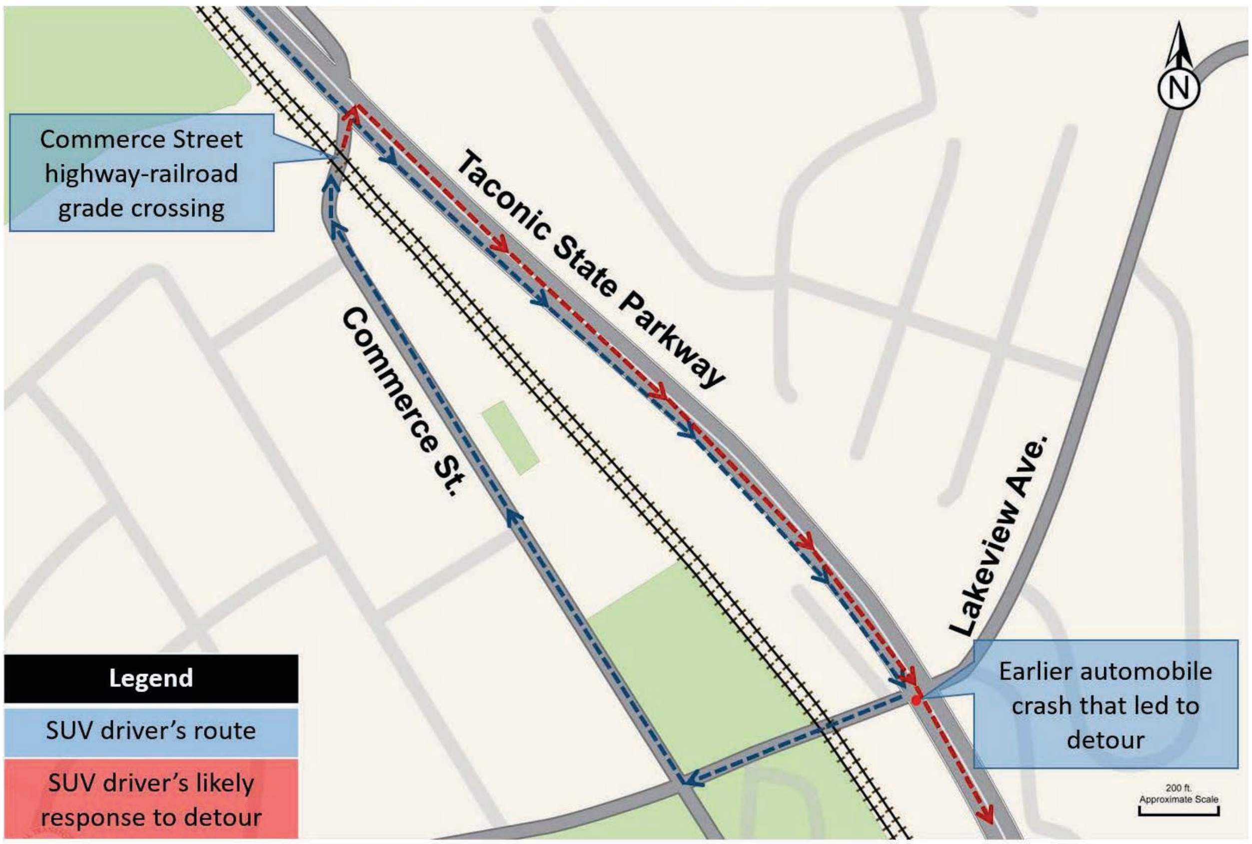


**Figure 4.** Map of the driver's route. (Source: Google Maps.)

A motorist (witness) who was traveling behind the SUV when the accident occurred described to investigators that heavy traffic on Commerce Street was "slow and inching along". The witness said he was traveling behind the SUV at the approach to the grade crossing and that traffic stopped. He said that his vehicle, along with the SUV, had stopped for a "few" seconds when he observed the warning system gate arm begin to lower. The witness said the SUV was

[4] Taconic State Parkway is a divided four-lane parkway, with two lanes for each direction.

sitting within the boundary of the grade crossing when the warning system at Commerce Street activated. (See figure 5.)

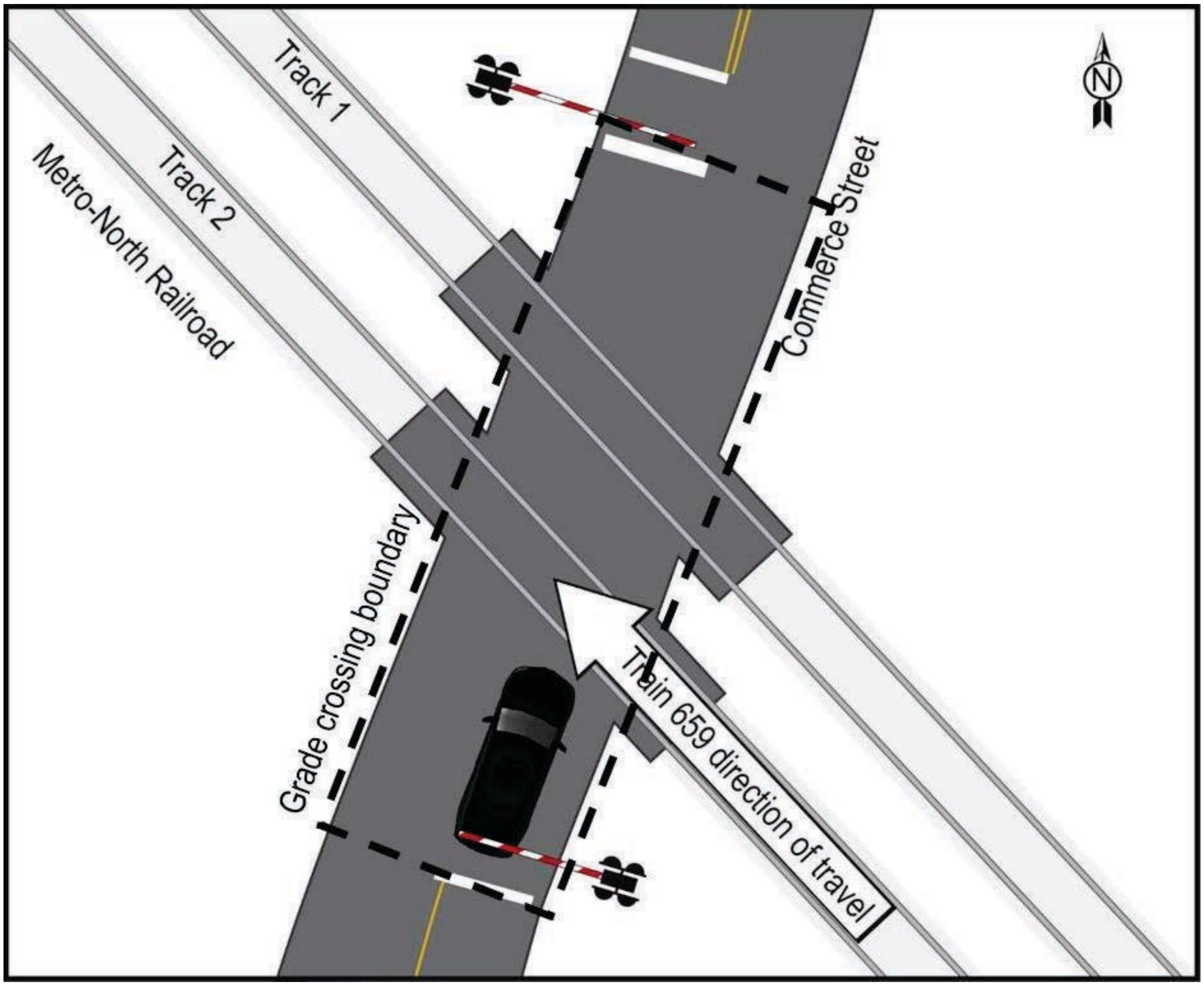


**Figure 5.** Illustration of the grade crossing with the gate arm on the rear of the SUV. (Not to scale.)

Investigators asked the witness if the gate arm struck the SUV while it was moving; he answered, "No; it [the SUV] was stopped." According to the witness, the gate arm lowered on to the rear portion of the SUV. The witness said he looked in his rearview mirror, saw no vehicles behind him, and backed up his vehicle, believing the SUV driver would do the same. The witness said that after he backed his vehicle up about one car-length, he saw the driver of the SUV exit the vehicle, slowly walk around to the rear of the SUV, and touch the gate arm. He characterized the driver's behavior as calm, and presumed it was because the SUV was not on the track. He said that the front of the car was "just barely making it," and he believed that the front of the SUV was very close to—but not on—the railroad track.

The witness said the driver turned and made eye contact with him after examining the gate arm on the rear of the SUV. From inside his vehicle, the witness motioned to the driver to back up. The witness began backing up his vehicle, while motioning with his hand for the driver to do the same.

The witness said the driver turned away from him and re-entered the SUV. The witness said he had expected the SUV to back up; however, after a slight pause the SUV moved forward. The SUV moved forward only about one car-length before the train struck it. The witness told investigators he could not see if there was traffic ahead of the SUV that prevented the driver from moving the SUV forward off the tracks.

### 1.2.2 SUV Driver

Investigators obtained information about the driver from interviewing the driver's spouse, and examining employee time and attendance records, medical records, and cell phone records.

#### 1.2.2.1 Recent Activity and Sleep History

Information from cell phone records and interviews with her spouse and co-workers formed the basis of investigators' reconstruction of the driver's recent activity history and opportunity for rest. Table 1 summarizes the driver's activities for the 72-hour period leading up to the accident.

**Table 1.** Driver activities prior to the accident.

| February 1, 2015 | | |
|---|---|---|
| **Time** | **Event** | **Source** |
| 1:28 a.m. | Last text sent before available rest period | Cell phone records |
| 8:45 a.m. | Driver wakes up | Spouse interview |
| 9:00 a.m. | Driver leaves home | Spouse interview |
| 10:38 a.m. | First outbound text message of the day | Cell phone records |
| 6:34 p.m. | Last phone call of the day | Cell phone records |
| **February 2, 2015** | | |
| **Time** | **Event** | **Source** |
| 12:00 a.m. | Driver goes to bed | Spouse interview |
| 9:00 a.m. | Driver wakes up, works from home | Spouse interview |
| 9:47 a.m. | First outbound text message of the day | Cell phone records |
| 9:29 p.m. | Last phone call of the day | Cell phone records |
| **February 3, 2015** | | |
| **Time** | **Event** | **Source** |
| 12:00 a.m. | Driver goes to bed | Spouse interview |
| 9:00 a.m. | Driver wakes up | Spouse interview |
| 9:21 a.m. | First phone call of the day | Cell phone records |
| 9:44 a.m. | Driver begins shift at work | Employer records |
| 6:00 p.m. | Driver ends shift at work | Employer records |
| 6:11 p.m. | Last phone call before accident occurs[a] | Cell phone records |
| 6:26 p.m. | Accident occurs | |

[a] The driver's cell phone records indicate this was an incoming call from the spouse that lasted 8 minutes, 41 seconds. The driver was not using the cell phone when the accident occurred.

During an interview, the driver's spouse provided information on the driver's recent sleep history and general sleep health. Table 2 summarizes the driver's opportunity for sleep. The reported times are approximate.

**Table 2.** Driver's opportunity for sleep.

| From | | To | | Elapsed Time |
|---|---|---|---|---|
| Date | Time | Date | Time | (approximate) |
| February 1 | 1:27 a.m. | February 1 | 8:45 a.m. | 7 hours 18 minutes |
| February 2 | 12:00 a.m. | February 2 | 9:00 a.m. | 9 hours |
| February 3 | 12:00 a.m. | February 3 | 9:00 a.m. | 9 hours |

The driver's spouse described the driver's sleep habits in the days leading up to the accident as typical; she usually stayed up until close to midnight and got up around 9:00 a.m. He said that he considered her sleep health, generally speaking, as normal and indicated she usually got sufficient sleep.

The driver's spouse said he knew of no recent life stressors that would have affected the driver's emotional health. Additionally, he stated that he spoke on the phone with her on the day of the accident, as she drove to an appointment with a potential business client. The driver's spouse said that the driver seemed normal during the conversation, and was focused on meeting the potential client.

The Metro-North Police Department contacted the potential business client regarding the planned meeting with the driver. According to the potential client, she and the driver planned to meet at a coffee shop in Scarsdale, New York, at 6:15 p.m. on the day of the accident. The driver texted the potential client around 5:45 p.m., saying she was working late and they would meet at 6:30 p.m. The driver's employment record indicated she worked until 6:00 p.m. on the day of the accident. After the driver failed to show up for the meeting, the potential client said she made several unsuccessful attempts to contact her.

#### 1.2.2.2 Cell Phone Use

Investigators reviewed the driver's cell phone records to determine if cell phone use at the time of the accident may have been a distraction. The cell phone records indicated that the driver was not using the cell phone when the accident occurred. The cell phone records further indicated there were two text messages sent to the potential client at 5:40 p.m. and 5:43 p.m., before the driver left work. The driver last communicated with her spouse on the cell phone at 6:11 p.m., after she left work and while driving to meet the potential client. The driver's spouse stated that during the call he provided the driver with directions to her destination. The call ended 6 minutes before the accident occurred. Although no evidence was available to indicate whether or not the driver used a hands-free device during that conversation with her spouse, he stated in an interview with investigators that the driver's cell phone automatically connected to the SUV's integrated hands-free system when the phone was detected inside the vehicle. The driver's spouse also said that the driver had usually used it to make phone calls while driving.[5]

[5] New York State law prohibits the use of hand-held cell phones or portable electronic devices while driving. However, using a hands-free device is acceptable. New York Vehicle and Traffic Law § 1225-C (2014).

#### 1.2.2.3 Medical Factors

Medical records indicated that the driver's primary care physician was treating her for hypothyroidism at the time of the accident. The driver's spouse said she had successfully managed the symptoms of the condition for several years, with her most common symptom being fatigue. However, the driver had not complained of being fatigued in the days prior to the accident.

Although the driver wore contact lenses, information in her medical records indicated her primary care physician characterized her vision as normal. According to her spouse, the driver routinely wore contact lenses and had adapted well to them.

No information in the driver's medical records indicated she had hearing problems, and her spouse described her hearing as good, with no known issues.

Following the accident, investigators obtained a postmortem blood sample from the driver, and sent it to the Federal Aviation Administration's (FAA) Bioaeronautical Research Sciences Laboratory (an organizational unit within the Civil Aerospace Medical Institute [CAMI]) for analysis. (FAA 2017) The analysis, completed on April 8, 2015, showed the driver tested negative for alcohol and other drugs.[6]

#### 1.2.2.4 Licensing

At the time of the accident, the driver held a valid New York Class D noncommercial driver's license.[7] The driver first obtained her license on March 27, 1995, and her current license was slated to expire on March 27, 2020. The license had a corrective lenses restriction.[8]

#### 1.2.2.5 Driving History and Experience

An inquiry through the New York Department of Motor Vehicles indicated the driver had three points assessed against her driving record at the time of the accident. The points were assessed for a November 2013 conviction for passing a red light. She had no record of convictions or accidents in the National Driver Registry.[9]

Investigators could find no information regarding the driver's initial driver training. Her spouse told investigators that she had been a licensed driver since she was a teenager. He further stated that he had known her since she was 25 years old and she had been a safe driver throughout that time. He recalled her being involved in two minor accidents, but no major accidents. He also stated that the driver did not typically encounter grade crossings and was not familiar with them.

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[6] The FAA laboratory tests for more than 1,300 substances.

[7] A New York Class D driver's license allows the license holder to operate a passenger car or truck with a gross vehicle weight rating of 26,000 pounds or less, or a combination vehicle in which the towed vehicle has a maximum gross weight of 10,000 pounds, or if the combined weight of the two vehicles is 26,000 pounds or less.

[8] The New York Department of Motor Vehicles requires a driver who needs eyeglasses or contact lenses to pass the required vision test to obtain a "corrective lenses" restriction on their license.

[9] The National Driver Registry is a database containing information on drivers in the United States who have had their licenses revoked or suspended, or who have been convicted of serious traffic violations.

#### 1.2.2.6 Vehicle Familiarity

The 2011 Mercedes Benz ML350 SUV involved in this accident had an electronic gear-selection lever located on the right side of the steering column. According to the driver's spouse, he and the driver purchased the SUV about 3 months prior to the accident, and she used it as her primary means of transportation. He stated that the driver liked the vehicle and had not experienced any difficulties operating the electronic gear-selection lever.

Investigators obtained and examined an exemplar 2011 Mercedes Benz ML350. The gear-selection lever is electronically operated, and etching on the lever indicates the movements required to make gearshift selections. A driver must depress the brake pedal and move the lever up or down to select the desired vehicle direction (forward or reverse). The button at the end of the gear-selection lever puts the vehicle into park. (See figure 6.)

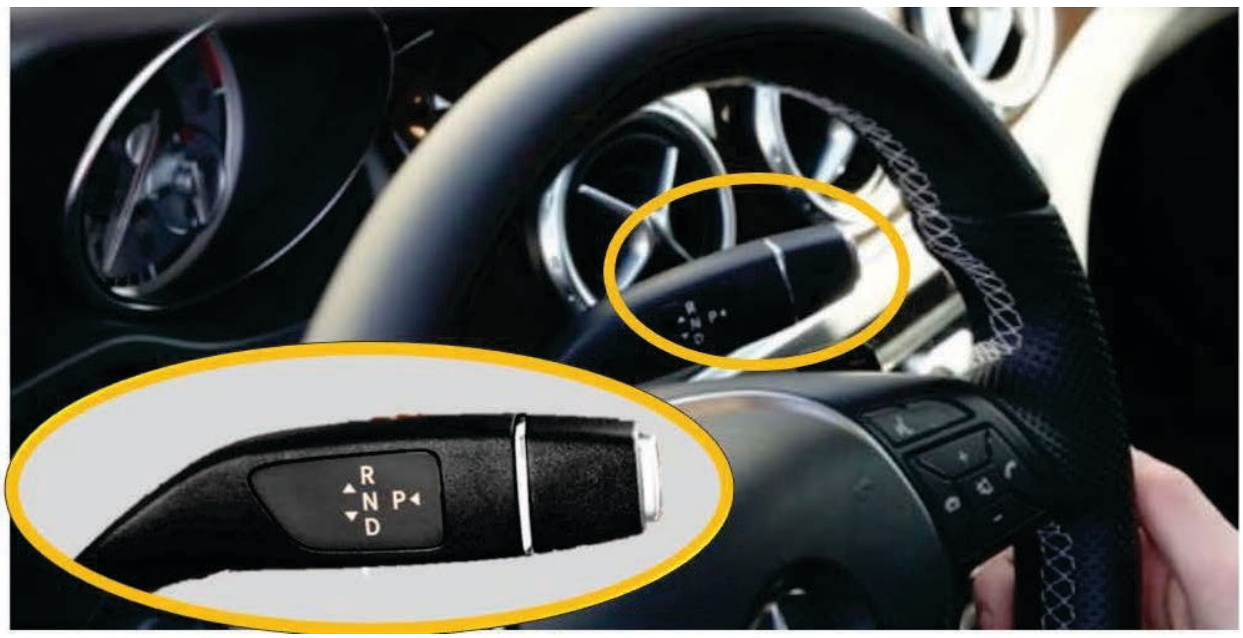


**Figure 6.** 2011 Mercedes Benz ML350 electronic gear-selection lever.

### 1.2.3 SUV Inspection and Recalls

The SUV was registered in the state of New York on December 18, 2014, and the registration was valid until December 2016. The SUV passed a required annual New York state inspection on December 22, 2014. (State of New York Department of Motor Vehicles [NYDMV] 2017)

Investigators queried the National Highway Traffic Safety Administration's (NHTSA) database for recalls associated with the 2011 Mercedes SUV, and found one recall related to the driver's-side frontal airbag. (NHTSA 2017) Additionally, NHTSA's Office of Defect Investigation (ODI) listed no complaints or investigations related to the operation of the electronic gear-selection lever for the 2011 Mercedes Benz ML350. (ODI 2017)

## 1.3 Highway Factors and Railroad Grade Crossing

### 1.3.1 Commerce Street Grade Crossing

Commerce Street is a northwest-southeast, two-lane asphalt road that turns slightly northeast and crosses the railroad tracks at milepost 26.6 and then intersects with the Taconic State Parkway. The Taconic State Parkway is a restricted four-lane divided principal and limited access parkway for passenger car vehicles only, while Commerce Street is an unrestricted two-lane undivided minor arterial. (See figure 7.)

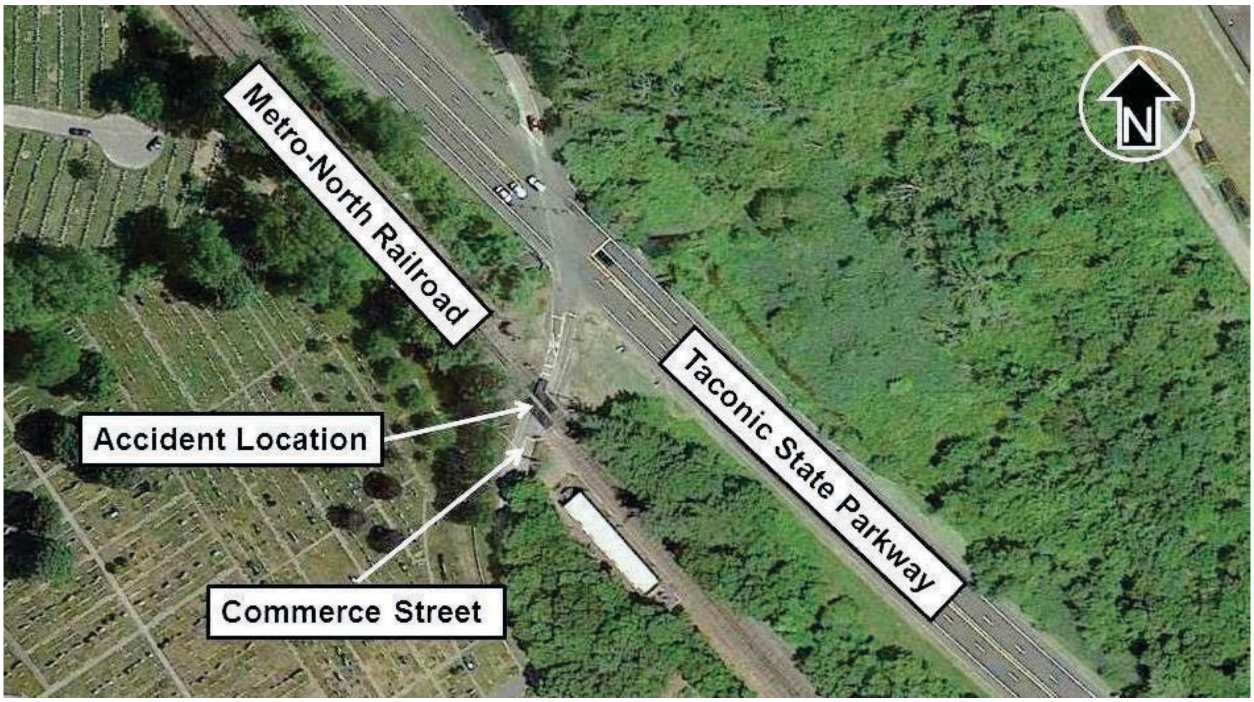


**Figure 7.** Accident location. (Modified from Google Earth.)

Solid yellow double lines that were each 6 inches-wide separated the through lanes of Commerce Street. An edge line separated the through lane and shoulder. The edge line consisted of a 6-inch-wide solid white line. The total width of the two-lane cross section was 18 feet-wide southwest of the grade crossing and 20 feet-wide northeast of the grade crossing. The grade crossing at Commerce Street and the Metro-North tracks formed about a 62° angle. The distance from the farthest eastern rail to the western edge line of the intersection of Commerce Street and Taconic State Parkway was 109 feet. (See figure 8.)

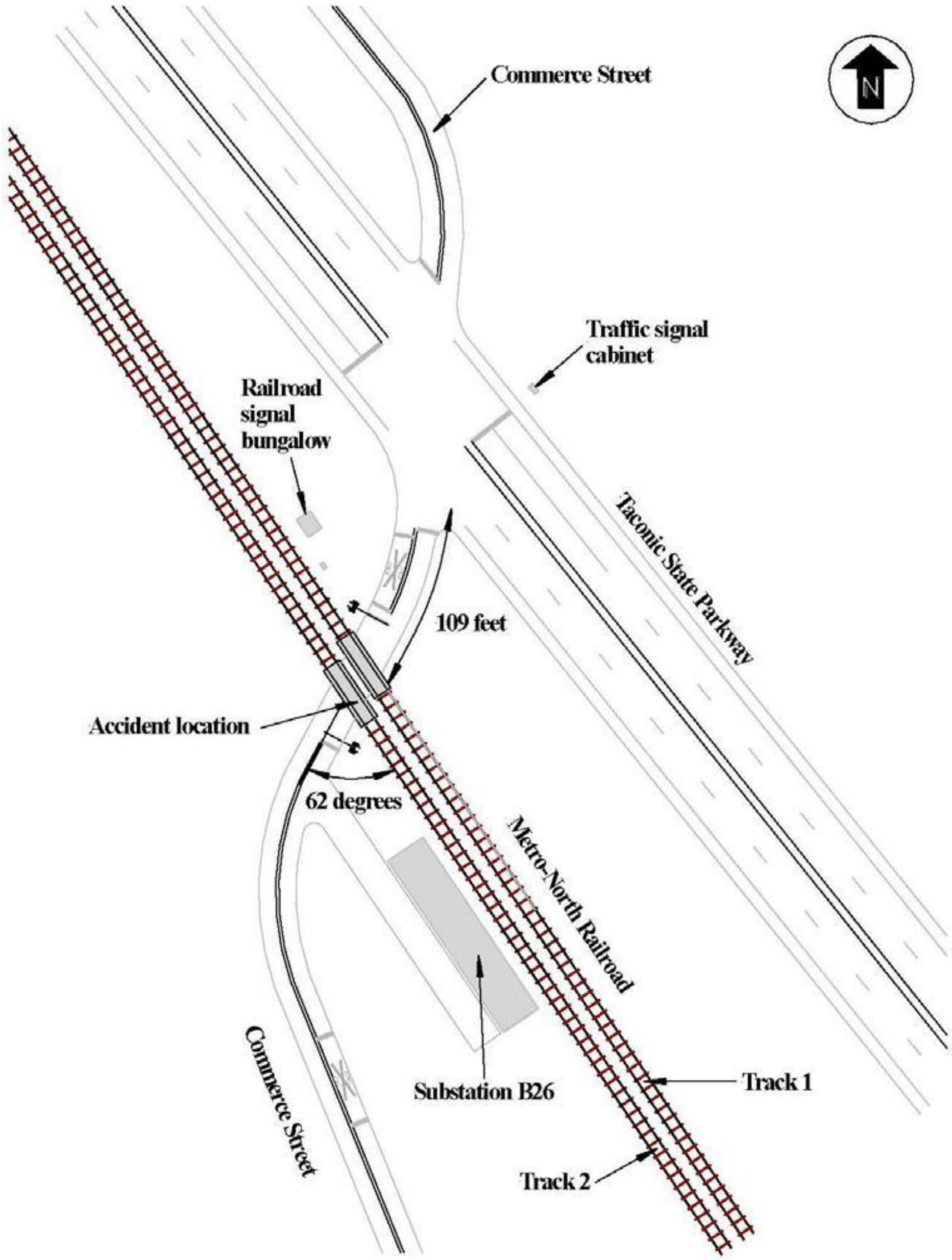


**Figure 8.** Accident site. (Not to scale.)

The highway intersection at Commerce Street and Taconic State Parkway did not have video monitoring devices to allow investigators to determine the extent of the traffic congestion at Commerce Street prior to the accident.

### 1.3.2 Highway Grade Crossing Warnings

A reflectorized grade crossing pavement marking symbol was located in a through lane on the northwest approach to the Commerce Street grade crossing, with its center about 252 feet from the nearest rail. A grade crossing advance warning symbol (yellow warning sign) was located about 160 feet from the nearest rail. A "Do Not Stop on Tracks" sign was located about 65 feet from the nearest rail and a grade crossing warning crossbuck indicating two tracks was 17 feet before the nearest rail.[10] A reflectorized white stop line, measuring 16 inches wide and 10 feet long, was located about 4 feet from the automatic gate. (See figure 9.)

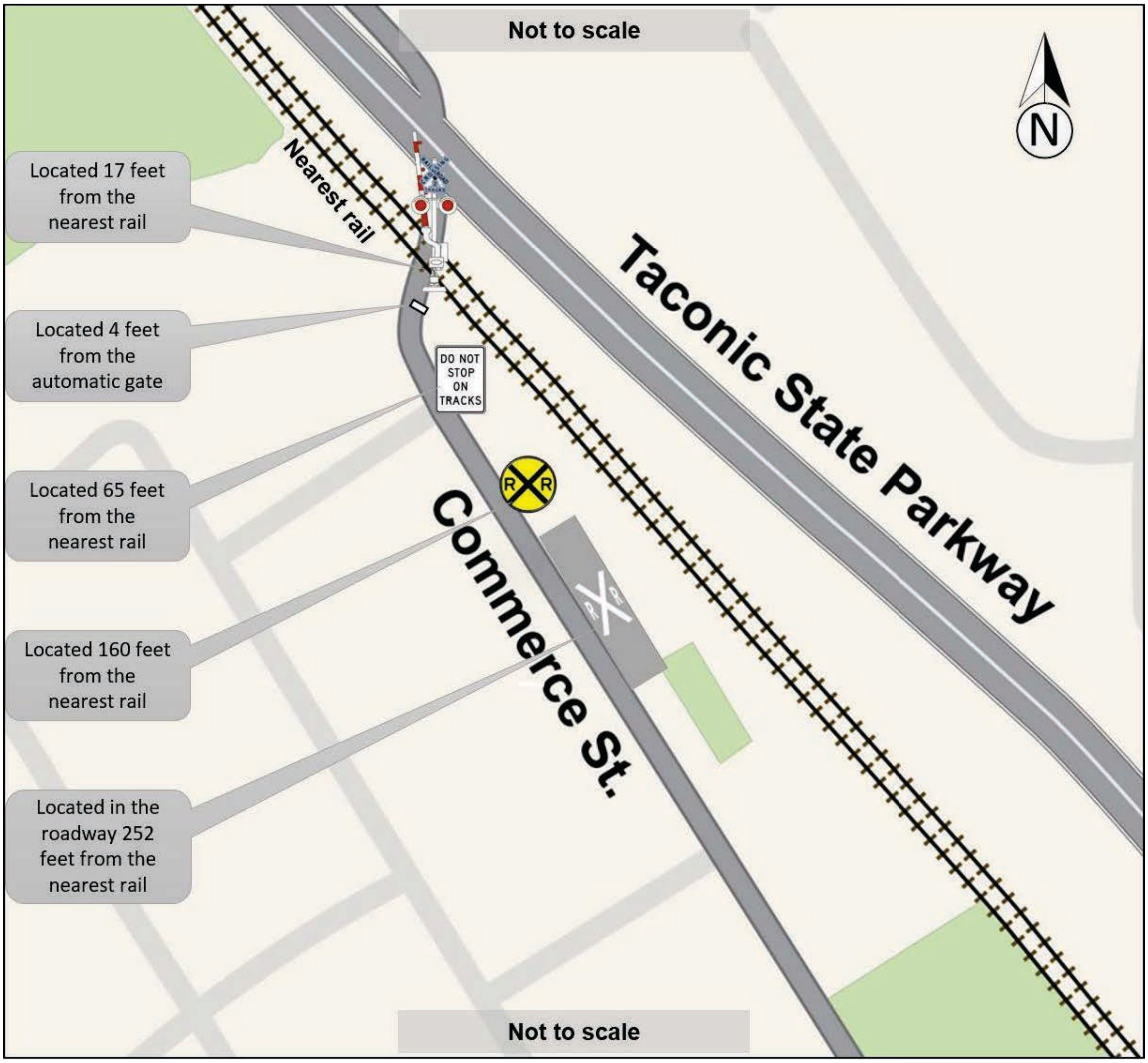


**Figure 9.** Warning sign locations on the approach to the Commerce Street grade crossing.

[10] A *crossbuck* is an X-shaped highway warning sign at a highway-railroad grade crossing with the words "railroad crossing" printed on the sign.

### 1.3.3 Commerce Street Grade Crossing Warning System

The warning system at the Commerce Street grade crossing consisted of reflectorized flashing lights and gates, including eight 12-inch diameter flashing light-emitting diode (LED) light units configured for bidirectional operation, and two gate arms mounted on two signal masts; however, it did not have bells.[11] This system provided warning for both directions of traffic on Commerce Street. One gate arm extended across one lane for the northeast direction of Commerce Street and a second gate arm extended across the southwest lane. Each aluminum and fiberglass gate arm had alternating red and white reflective striping and was equipped with three 3-inch LED light units mounted along the top. (See figure 10.)

Postaccident testing confirmed that when the warning system activated, the light unit mounted at the tip of the gate arms remained lit, while the other two light units flashed alternately. Both signal masts had signs affixed with a toll-free telephone number to report emergencies.


**Figure 10.** Approach of the Commerce Street grade crossing, facing northeast.

[11] (a) Bells are only required for grade crossing warning systems where pedestrian crossings are present. (b) Although most grade-crossing gates are designed to break away, including the one at the Commerce Street grade crossing, there are no requirements for them to do so.

The train detection and warning system activation is configured using overlay track circuits and provided a minimum of 35 seconds of warning time until a train traveling at the maximum authorized speed of 60 mph arrived at the grade crossing. The approach track circuits for northbound trains extended 3,078 feet south from the center of the Commerce Street grade crossing, and the approach track circuits for southbound trains extended 3,088 feet north from the center of the Commerce Street grade crossing. Whistle boards were located about 1,340 feet from the grade crossing for northbound trains.[12]

### 1.3.4 Taconic State Parkway and Commerce Street Traffic Signals

Traffic signals directed highway traffic in all directions through the intersection of Taconic State Parkway and Commerce Street.[13] The highway traffic signal system had a simultaneous preemption connection with the grade crossing warning system.[14] After the traffic signal controller received a preempt signal from the railroad train detection circuit, it would immediately transfer to a special operating mode to transition out of the active phase(s) and into a track clearance phase(s).[15] When the track clearance phase began, vehicles could clear out of the intersection and the grade crossing.

The railroad train detection circuits provided one relay contact that opened a traffic signal circuit after detecting a train on either of the Commerce Street grade crossing approach track circuits and triggered the highway traffic controller to initiate the preemption sequence of the traffic signals and simultaneously activate the grade crossing warning devices.

The traffic signal at the Commerce Street and Taconic State Parkway intersection was designed with two preemptions. A loop detector in the pavement of the southwest approach of the Commerce Street grade crossing for southbound vehicles turning from Taconic State Parkway on to Commerce Street toward the grade crossing activated preemption #1.[16] (See figure 11.)

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[12] A *whistle board* (or *whistle post*) is a sign along the track marking a location where an engineer should begin sounding the horn or whistle.

[13] A Siemens 2070L Advanced Transportation Controller microprocessor controlled the traffic signals.

[14] Examples of preemption control include a sequence of signal phases and timing to expedite and/or provide additional clearance time for vehicles to clear the tracks prior to the arrival of rail traffic, and a sequence of signal phases to display a steady red indication to prohibit turning movements toward the tracks during the approach of passing rail traffic.

[15] The preemption of a highway traffic signal requires an electrical circuit between the control device of the railroad's grade crossing warning system and the controller assembly of the highway department's traffic signal. The railroad is only responsible for the maintenance and testing of its interconnections.

[16] A *loop detector* is an inductive-loop traffic sensor embedded in the road that can detect vehicles arriving or passing at a certain point, for instance when approaching a traffic light.

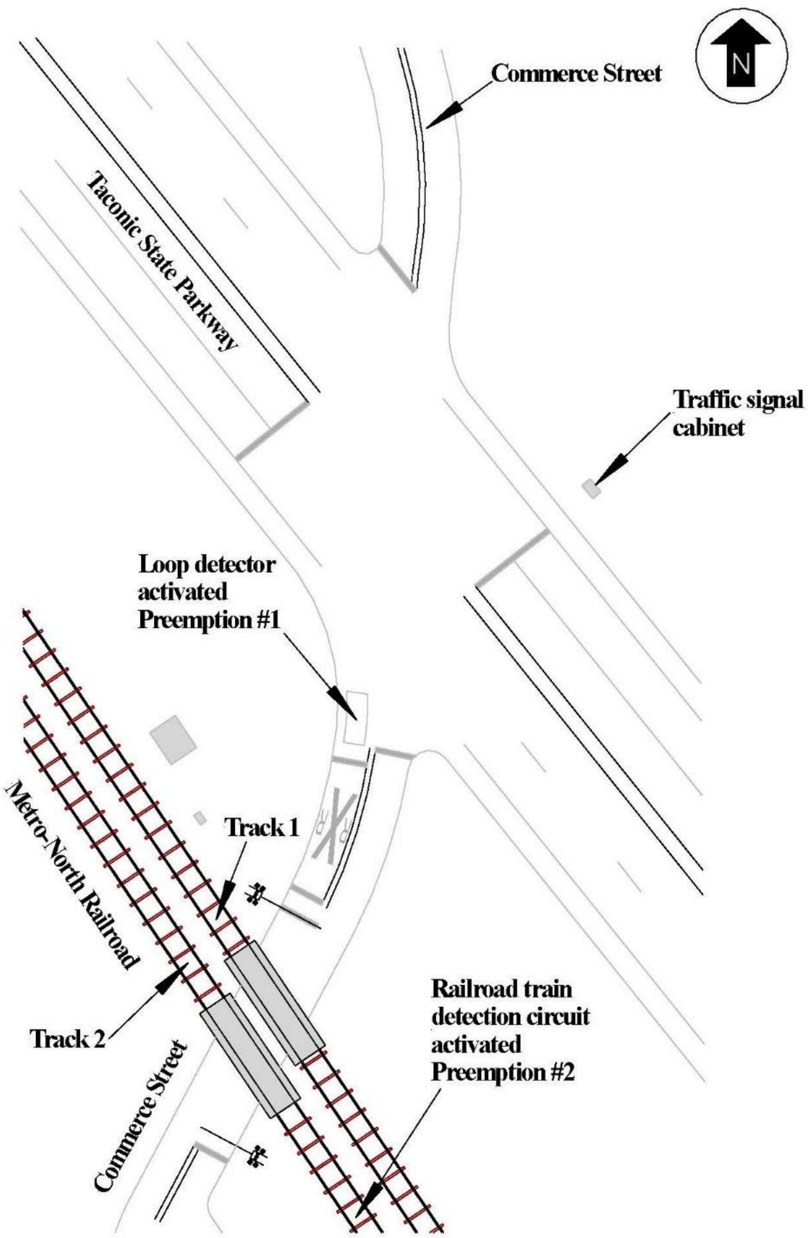


**Figure 11.** Traffic signal preemption at accident site. (Not to scale.)

Preemption #1, when activated, allowed vehicles to clear the Taconic State Parkway and Commerce Street intersection before any additional vehicles could turn or travel through the intersection, avoiding the potential of trapping vehicles in the intersection of Commerce Street and Taconic State Parkway.

The railroad train detection circuit, shown in Figure 11, is designed to activate Preemption #2 to provide green signal time for highway vehicles traveling northeast on Commerce Street to clear the queue. When Preemption #2 activates, the traffic signal for north and southbound traffic on the Taconic State Parkway terminates the active green phase, activates the corresponding yellow and red phases, and turns green only for vehicles traveling northeast on Commerce Street. This phase was designed to remain green for a minimum of 2 seconds and a maximum of 10 seconds, followed by 4 seconds of yellow.

Depending on the traffic signal phase in effect, the clearance phase of the traffic signal for the northeast approach on Commerce Street could take a maximum of 7 seconds to start. After detecting a train, the traffic signal phases for northbound and southbound Taconic State Parkway are designed to cycle to red. The traffic signals for vehicles approaching the grade crossing traveling southeast on Commerce Street would also cycle to red, and would remain red while the warning system was activated.

### 1.3.5 Railroad Warning System Data Logger

A Safetran Event Analyzer Recorder II (SEAR II) data logger was a component of the railroad warning system and recorded information associated with train movements through the Commerce Street crossing. National Transportation Safety Board (NTSB) investigators obtained the railroad warning system data log for all train movement for both tracks through the Commerce Street crossing from February 2, 2015, until the time of the accident.

The data logs for the Commerce Street warning system showed train 659 occupying the southern approach track circuit on main track 2 at 6:25:34 p.m. The data indicated the warning system activated 39 seconds before the train occupied the island circuit.[17] As mentioned in section 1.3.3, the design of the Commerce Street grade crossing provided a minimum of 35 seconds of warning time, but a train moving slower than the maximum authorized speed will result in longer warning times.

### 1.3.6 Grade Crossing Warning System

On February 4, 2015, NTSB investigators conducted a field examination of the grade crossing warning system and highway traffic-light preemption system at the intersection of Commerce Street and the Taconic State Parkway. An examination of the grade crossing warning equipment at Commerce Street found the signal bungalow and all flashing light units to be locked and secured with no evidence of vandalism or tampering. Investigators also inspected both approach track circuits and verified each was properly operating in both track directions approaching the Commerce Street grade crossing.

During postaccident testing, investigators determined the gate arms began lowering 4 seconds after the flashing light units activated. The gate arms reached a full horizontal position 9 seconds after the gate arms began their descent—13 seconds after the flashing light units activated. Investigators did not identify any sight distance issues or visual obstructions that would

[17] (a) Title 49 *Code of Federal Regulations* (*CFR*) 234.225 "Activation of Warning System," says a highway-rail grade crossing warning system shall be maintained to activate in accordance with the design of the warning system, but in no event shall it provide less than 20 seconds warning time before the grade crossing is occupied by rail traffic. (b) The *island circuit* refers to a short track circuit that spans the length of the paved roadway on each of the railroad tracks at a grade crossing.

interfere with the ability of drivers on the highway to see the flashing light units from either direction.

Investigators verified that the warning system preemption circuit in the Metro-North signal case was properly configured and functioned as designed. Activation of the warning system would trigger the correct signal to the highway traffic signals, which would then initiate the railroad preemption sequence phase.

## 1.4 Metro-North Railroad

Metro-North operates over three main lines east of the Hudson River, all originating at Grand Central Terminal (GCT) in Manhattan, New York. The Hudson Line extends north toward the Hudson River Valley to Poughkeepsie, New York. The Harlem Line extends north to Wassaic, New York. The New Haven Line extends northeast to New Haven, Connecticut, with branch lines extending to New Canaan, Danbury, and Waterbury, Connecticut. Metro-North also owns equipment and maintains infrastructure on two lines west of the Hudson River (the Port Jervis and Spring Valley Lines) in New Jersey and New York. New Jersey Transit operates Metro-North trains on those lines.

Metro-North is one of the largest and busiest commuter railroads in the United States. It operates about 700 passenger trains daily and has an annual ridership of about 83 million passengers. In addition, National Railroad Passenger Corporation (Amtrak) operates about 22 trains each weekday on Metro-North tracks. CSX Transportation, Norfolk Southern Railroad, Consolidated Rail Corporation, and several short line railroads also operate freight trains on Metro-North tracks.

Metro-North operates trains with a number of different types of passenger equipment. Some are electric-powered multiple unit trains that use third rail or overhead catenary wires, others are diesel-powered locomotives that push or pull passenger trains, and others are combinations of the two. Some diesel-electric locomotives operate into GCT and transition to third rail power in underground areas. Railroad traffic controllers working from the Metro-North Operations Control Center in GCT are responsible for train operations on the Hudson, Harlem, and New Haven Lines.

### 1.4.1 Railroad Operations

Metro-North train 659 originated from GCT with a destination of Southeast Station in Brewster, New York. The train crew, consisting of an engineer and a conductor, performed all required predeparture equipment tests after receiving the train at GCT. At the time of the accident, the engineer was in the control compartment of the lead railcar and the conductor was located in the train's sixth railcar. On the day of the accident, the train departed GCT on schedule—at 5:44 p.m.—and the trip was uneventful until the point of the accident.

Train 659's first scheduled stop was Chappaqua, New York, which was north of the accident location. (See figure 12.) The train passed North White Plains Station on time, at about 6:22 p.m. The train proceeded within the maximum authorized speed until the accident.

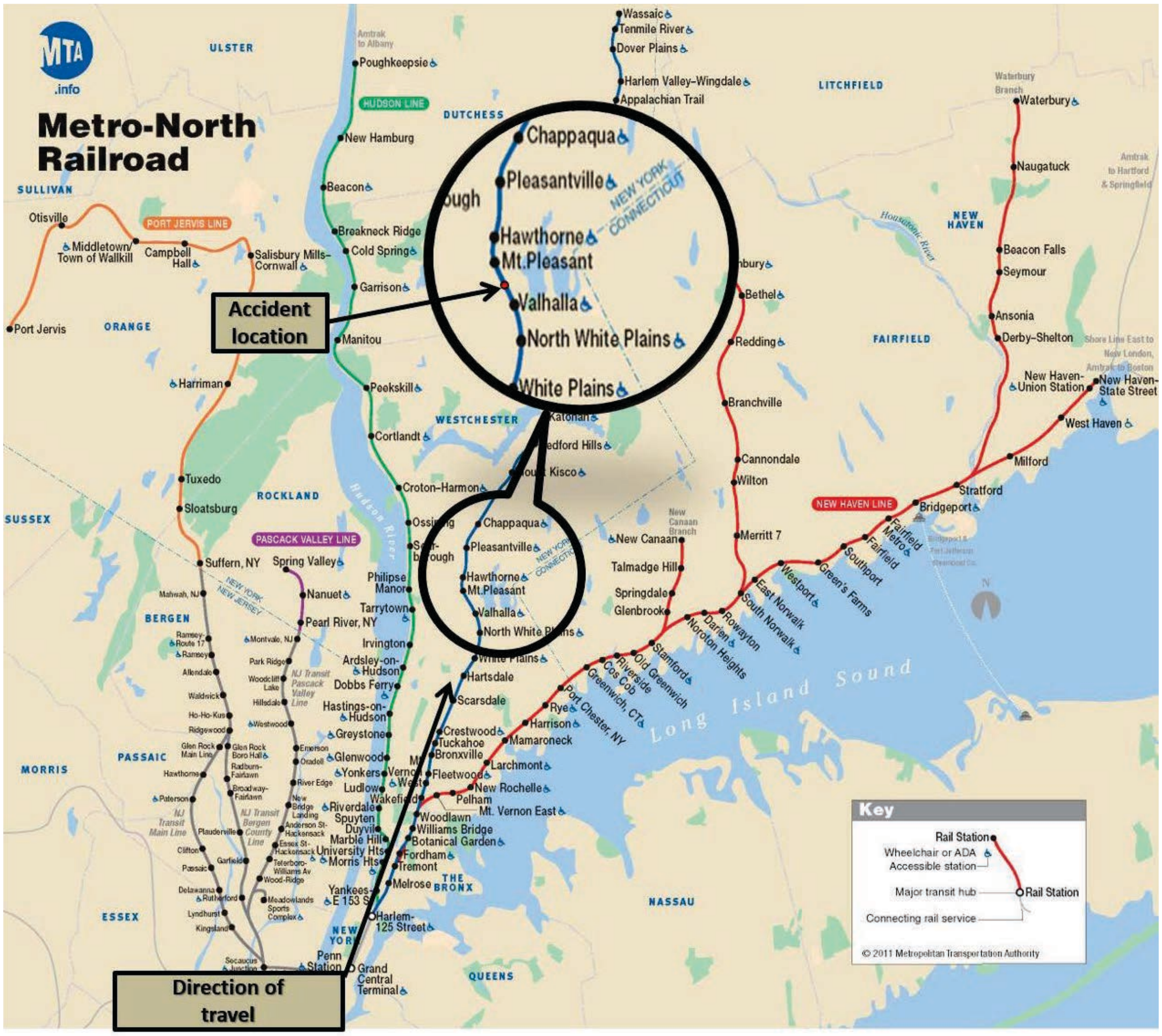


**Figure 12.** Metro-North system map highlighting the accident location. (Source: Metropolitan Transportation Authority.)

## 1.4.2 Method of Operation

Train movements on the Harlem Line of Metro-North are governed by operating rules, timetable instructions, general notices, and traffic control system signal indications, including cab signals.[18] There are no wayside signals between control points.[19] The railroad at Commerce Street is multiple main track, with two tracks designated as track numbers 1 and 2.[20] On the day of the

[18] *Cab signals* are located in the engineer's compartment or cab, and indicate a condition affecting the movement of a train or locomotive. They are used in conjunction with interlocking signals, and in conjunction with or in lieu of block signals.

[19] *Wayside signals* are fixed signals that are located along a track right-of-way.

[20] *Multiple main track* means that two or more tracks are signaled for travel in both directions.

accident, train 659 passed a proceed signal (green aspect) at the North White Plains Station, just prior to Valhalla Station, which authorized the maximum authorized speed.

### 1.4.3 Metro-North Train 659

Metro-North train 659 consisted of eight electrically powered Bombardier M-7 railcars that operate in a multiple unit arrangement and are powered by a 700-volt direct current (DC) third rail system. The lead railcar (Metro-North 4333) did not have an outward-facing (track image) video recorder.[21] The lead railcar was also equipped with an external active alerting light system, also known as auxiliary lights. The auxiliary lights are arranged to flash on approach to a grade crossing, as required by Title 49 *Code of Federal Regulations* (*CFR*) 229.125.

The engineer told investigators that he noticed a reflection of light at or near the Commerce Street grade crossing from about 1,200 feet away, but initially could not determine what was causing the reflection. He said he then realized that the reflection had come from a vehicle that was fouling the Commerce Street grade crossing.[22] The engineer said, "after proceeding a little bit closer, I realized it was the front end of a SUV, a black SUV."[23] The engineer then told investigators that "the front of [the SUV] was fouling the track, and which anyway, if they weren't able to move, I still would have hit—even with braking [*sic*]." The engineer said that after realizing the SUV was in the grade crossing, he immediately applied the train's emergency air brakes and sounded the horn on the lead railcar.

The engineer told investigators that at about one railcar-length (85 feet) before the collision, the SUV moved further into the grade crossing and stopped on the tracks, in the direct path of the train. He said he then stood up and braced himself for the impact. The engineer told investigators he did not see vehicle traffic in front of the SUV before the collision, and believed the SUV could have cleared the crossing.

#### 1.4.3.1 Event Recorder Data

According to the event recorder data from train 659, the train horn began to sound at 6:25:56 p.m. The data indicated this was about 1,424 feet before the point of collision (POC). The event recorder data showed the train was traveling at 59 mph when the engineer activated the emergency air brakes, 14 seconds after sounding the horn and about 260 feet from the collision. Event recorder data indicated the train horn sounded four times before the collision. Event recorder data showed the train collided with the SUV at a speed of about 51 mph at 6:26:13 p.m., about 17 seconds after the engineer sounded the horn.

[21] Federal regulations do not require outward-facing video recorders. However, Metro-North was in the process of installing them, but had not yet equipped this locomotive.

[22] According to the FRA, *fouling* a track means the placement of an individual or equipment within 4 feet of the nearest rail or in such proximity to a railroad track that the individual or equipment could be struck by a moving train or other on-track equipment.

[23] The transcript of the engineer's interview is available in NTSB Docket DCA15MR006.

### 1.4.3.2 Train Horn Requirements

The Federal Railroad Administration (FRA) requires that trains sound their horns to warn drivers and pedestrians when approaching and entering grade crossings.[24] The requirement stipulates that engineers must begin sounding the horn at least 15 seconds, and no more than 20 seconds, before reaching a grade crossing: "If a train is traveling faster than 60 mph, engineers will not sound the horn until it is within 1/4 mile (1,320 feet) of the crossing, even if the train is less than 15 seconds away."

The horn must have a minimum warning sound level of 96 decibels (dB) at a distance of 100 feet from the front of the train. For the train horn to be effective, its sound must be 3 to 8 dB above the threshold of detection to be heard and 10 dB above ambient noise to attract attention. (FRA 2008)

Metro-North operating rules required train crews to test the horns of controlling railcars on a daily basis and ensure that they are in working order before departing the initial terminal. (Metro-North 2011)[25] Investigators recovered and examined what was left of the horn from the lead railcar of train 659. The fire from the accident heavily damaged the horn and postaccident testing could not be completed.

Investigators completed a sound study at the Commerce Street grade crossing, using an exemplar vehicle (2011 Mercedes ML350) and Metro-North trains with the same type of horn as the one on train 659's lead railcar.[26] This allowed investigators to assess the horn's sound levels from a driver's perspective. The study showed the sound levels as:

- The average sound level outside the test vehicle of the train horn for a train 100 feet from the grade crossing was 101.5 dB;
- The average ambient sound level inside the exemplar vehicle with the engine at idle was 43 dB;
- The sound levels inside the test vehicle began to measurably increase when the horn sounds from the test trains were 350 feet from the grade crossing; and
- The sound levels inside the test vehicle with a train 100 feet from the grade crossing averaged 93.5 dB, 50.5 dB greater than the ambient sound level.

### 1.4.4 Engineer's Sleep/Wake/Work History

Investigators reviewed the engineer's hours of service records for the 72 hours immediately prior to the accident. (See table 3.)[27] These records showed that the engineer worked two shifts in the 3 days prior to being called in to work on the day of the accident. His records showed that he

[24] See 49 *CFR* Part 222 "Use of Locomotive Horns at Public Highway-Rail Grade Crossings" for more information.

[25] Rule 4-E (1) – Engine horn must be tested and in working order prior to departure from initial terminal.

[26] Investigators used Bombardier M-7 railcars for this study.

[27] Title 49 *CFR* Part 228, Subpart F "Substantive Hours of Service Requirements for Train Employees Engaged in Commuter or Intercity Rail Passenger Transportation."

had more than the 8-hour minimum required rest period on all 3 days and had a rest period of over 23 hours prior to being called in to work the day of the accident.

**Table 3.** Engineer's 72-hour on- and off-duty history.

| Date | Time on duty | Time off duty | Total time on duty |
|---|---|---|---|
| January 31 | Day off | Day off | 0 Hours 0 Min. |
| February 1 | 5:08 a.m. | 1:26 p.m. | 8 Hours 18 Min. |
| February 1 | 11:59 p.m. | 9:59 a.m. (February 2) | 10 Hours 0 Min. |
| February 2 | Day off | Day off | 0 Hours 0 Min. |
| February 3 | 9:37 a.m. | Day of accident | Day of accident |

In his interview with investigators, the engineer stated he felt fully rested when he was called to work and during his shift on the day of the accident.

### 1.4.5 Cell Phone Use

A review of the engineer's cell phone records from the day of the accident determined that there were no calls or texts to or from his cell phone during his shift.

### 1.4.6 Toxicological Testing

The engineer provided a blood sample to investigators on February 3, 2015, following the accident. The investigators then sent the blood sample to the FAA's Bioaeronautical Research Sciences Laboratory (an organizational unit within CAMI) for testing. The analysis identified no alcohol or other drugs in the engineer's blood sample.

## 1.5 Metro-North's Track and Third Rail Power

The track through the Commerce Street grade crossing area was designated as Class 3 track and consisted of continuous welded steel rail on treated wooden ties, secured with tie plates and a combination of spikes and screws.[28] FRA Class 3 track standards required Metro-North to inspect the track twice each week. Investigators reviewed the Metro-North track inspection records from December 28, 2014, through the time of the accident, which indicated Metro-North was inspecting the track according to federal requirements. The last inspection, on January 30, 2015, recorded no defects.

Metro-North's third rail is a conducting rail that provides electrical power to the train. It was constructed from a rolled thick flange steel beam weighing 150 pounds per 3-foot section. Each section is 39 feet-long, but the length may be adjusted as needed during installation and maintenance. The third rail sections, joined together with bolts and splice bars, are attached to brackets attached to ties that support it with three bolts.[29] The conducting surface is on the bottom of the rail and is known as "under-running". In other words, Metro-North's electric trains collect

[28] Title 49 *CFR* Part 213 "Track Safety Standards" describes the maximum authorized speed on Class 3 track as 60 mph for passenger trains and 40 mph for freight trains.

[29] *Splice bars* join third rail sections together and include two bars and four bolts.

power to operate from the bottom side of the rail. The third rail has a protective cover. (See figure 13.)


**Figure 13.** Metro-North's third rail configuration.

Traction power substations B26 and B29, each four megawatt rectifier substations, supply power to the third rail system in the area of the Commerce Street grade crossing. (See figure 14.) Each substation contained electrical switchgear, circuit breakers, a supervisory control and data acquisition (SCADA) control cabinet, relays, rectifiers, transformers, and battery control systems.[30] Two 13,000 volt alternating current (AC) utility services supplied the substations, which convert the AC service to 700-volt DC service to power the trains. The substations are configured to supply power for both the north and south directions for each track.

The third rail may be located on either side of the track, often connected with a transition jumper where it changes sides.[31] Gaps in the third rail are common at all grade crossings. (See figure 14.) The power director's office, located at GCT, controls and monitors the substations

[30] (a) The *battery control system* provides extended power to operate the circuit breakers during both normal and emergency conditions. (b) *SCADA* is a system that operates with coded signal over communication channels to provide control of remote equipment. The control system may be combined with a data acquisition system by adding the use of coded signals over communication channels to acquire information about the status of the remote equipment for display or recording functions.

[31] A *transition jumper* provides electrical continuity between two segments of the third rail. In this case, transition jumper 2266 electrically joined the east and west third rails involved in this accident.

remotely. There were no security video cameras at substation B26, the substation closest to the Commerce Street grade crossing.

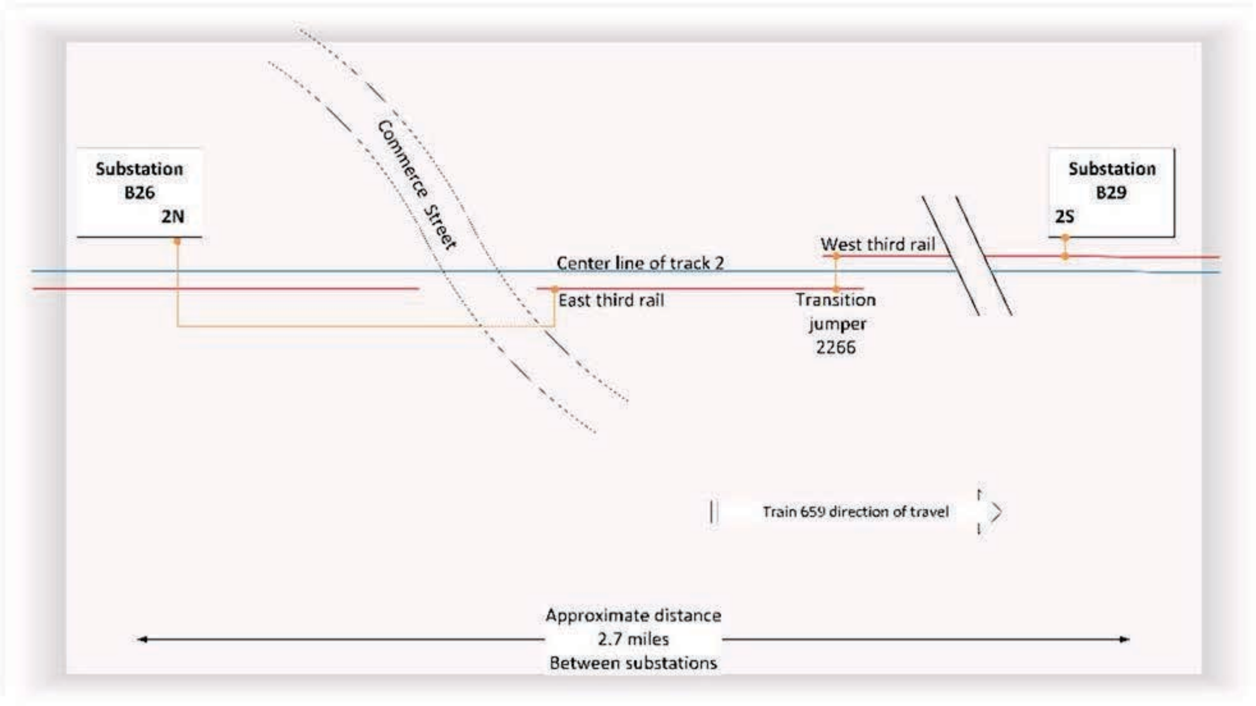


**Figure 14.** Simplified electrical schematic of traction power substations near Commerce Street. (Not to scale)

### 1.5.1 Third Rail Structure

In interviews with investigators, Metro-North's power director reported that he believed designers intended for the third rail system to break away (to the right side or left side of the track) from the train during specific types of accidents. He explained that based on his experience, the material and design of the splice bars allow them to break when a large force, perpendicular to the movement of a train, strikes them. The basis of the power director's belief was a 1984 accident at the Commerce Street grade crossing in which the third rail broke away from the train and did not damage the train.

### 1.5.2 Other FRA-Regulated Third Rail Properties

The FRA regulates four railway systems, in addition to Metro-North, that use a third rail system to power passenger trains: Long Island Rail Road (LIRR), Amtrak, Port Authority Trans-Hudson Corporation (PATH), and Southeastern Pennsylvania Transportation Authority (SEPTA). All are similar in design in that a rolled thick flange steel beam was used to construct the rail that provides electrical power to the train. PATH has initiated an upgrade to use a composite third rail made from aluminum and stainless steel. Like Metro-North, third rail power collection is under running on the LIRR and the Market-Frankford line on the SEPTA system. All other systems are top running, in which the system collects power from the top of the third rail.

### 1.5.3 Traction Power Data

Investigators examined the SCADA data from the traction power systems from the day of the accident to understand how long the third rail power was energized after the collision. The protective relaying circuit at substation B26 detected the first fault, indicating a protective circuit breaker trip, and logged it at 6:26:21 p.m., 8 seconds after the collision.

Protective circuit breakers for traction power substations attempt to reclose three times after they trip. This reclose feature attempts to repower the third rail and is designed into the traction power system because electrical power spikes occasionally occur during normal operations. The reclose feature mitigates unnecessary power outages for trains.

After the accident, as train 659 and the SUV continued to move north, they physically damaged transition jumper 2266, located about 300 feet north of the POC. (See figure 14.) The damage caused the east and west third rails to electrically disconnect from each other and isolated substation B26 electrically from the damaged west third rail.

As a result of damage to transition jumper cable 2266, the load measuring circuitry at substation B26 for the track 2 north circuit breaker was no longer detecting a fault on the east side of track 2 and re-energized. The reclose feature re-energized the east third rail at 6:26:28 p.m., 7 seconds after the circuit breaker tripped. This re-energized the last four cars of the train, which were contacting the east third rail.

At 6:26:51 p.m., a protective circuit breaker tripped at the B29 traction power substation de-energizing the power to the west third rail. At 6:27:02 p.m., the power director's office sent an open command for breaker at B29 for track 2 south.

At 6:27:50 p.m., 1 minute and 29 seconds after substation B26 detected the first fault, the power director's office sent an open (power off) command for the circuit breaker at B26 controlling track 2 north. This de-energized the third rail power between substation B26 and the last four cars of the train.

### 1.5.4 Third Rail Inspection Requirements

There are no federal requirements for third rail inspection standards. However, railroads may create their own requirements. The Metro-North power department's *Standard of Maintenance Manual* July 2005 edition requires an annual inspection of the third rail. (Metro-North 2005) However, Metro-North performs proactive and reactive inspections and repairs at a greater frequency.

Proactive inspections include patrols to identify both loose or missing insulator bolts, broken or loose bolts, worn insulators, broken or missing third rail covers, broken third rail splice bars, broken brackets, and planned work. Reactive inspections include searching for loose third rail joints and investigating low-voltage conditions, reports of arcing or burned brackets, circuit breaker trips, and missing current collector shoes. Investigators verified that Metro-North's inspection records complied with their own standards. The last inspection of the third rail at the grade crossing, on December 8, 2014, documented no defects.

## 1.6 Survival Factors

Table 4 provides, based on available evidence, a summary of the severity of injuries incurred in this accident.[32] Based on crew interviews, about 20 passengers were riding in the lead railcar at the time of the accident.

**Table 4.** Occupant injury summary.

| Occupant | Uninjured | Unknown | Minor | Serious | Fatal |
|---|---|---|---|---|---|
| 2011 Mercedes ML350 Driver | 0 | 0 | 0 | 0 | 1 |
| Metro-North Train 659 Crew | 1 | 0 | 1 | 0 | 0 |
| Metro-North Train 659 Passengers | ~630 | 1 | 3 | 6 | 5 |
| Total | ~631 | 1 | 4 | 6 | 6 |

Emergency medical services (EMS) transported 13 people to the hospital. There were no records of treatment for one person who was transported to the hospital. EMS transferred two other people to the hospital; however, those passengers were not diagnosed with an injury. Table 4 shows these people as uninjured.

Four of the passengers in the lead railcar died as a result of blunt trauma. Surface burns may have obscured injuries or underlying medical conditions for the fifth fatality. All five of the railcar fatalities sustained extensive surface burns, but did not have soot in their airways. The driver of the SUV died as a result of blunt force trauma.

## 1.7 Emergency Response

The accident occurred in Westchester County, New York, between Metro-North's Valhalla Station and Mount Pleasant Station. Valhalla is a hamlet of the town of Mount Pleasant, which has its own independent police department.

Because the accident occurred on railroad property, the primary law enforcement agency for this collision was the Metropolitan Transportation Authority Police Department (MTAPD); the primary fire/rescue agency was the Valhalla Volunteer Fire Department (VVFD), and the primary EMS agency was the Valhalla Volunteer Ambulance Corps. The nearest level-one trauma center was Westchester Medical Center (WMC) located in Valhalla, New York, just a few miles from the accident site. EMS transported most of the injured passengers to WMC.

The Westchester County Department of Emergency Services (DES) monitors incidents and receives notifications from the various emergency services agencies within the county. Westchester DES Emergency Communications Center (ECC) provided investigators with incident logs from the day of the accident, as extracted from its computer-aided dispatch system. ECC logged its first call at 6:28:08 p.m. and dispatched the VVFD at 6:28:25 p.m. VVFD arrived on

[32] The NTSB classifies serious injuries as any injury which: (1) Requires hospitalization for more than 48 hours, commencing within 7 days from the date of the injury; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface. (Classification based on 49 *CFR* 830.2)

scene at 6:34:24 p.m. The VVFD chief assumed incident command (IC) and established a command post on the Taconic State Parkway adjacent to the forward part of the train. EMS set up a triage area at the Commerce Street grade crossing and initiated a mass casualty and mutual aid response. Authorities closed both lanes of the Taconic State Parkway, from which VVFD staged firefighting operations.

The Metropolitan Transportation Authority (MTA) chief safety officer arrived on scene within a few minutes of the accident, and helped EMS responders identify the most effective access points for establishing the IC, fighting the fire, and conducting rescue operations. Emergency responders were aware of the potentially electrified third rail.

The fire progressed quickly inside the lead railcar and firefighters noted they had limited opportunity to evacuate it before it fully engulfed in fire. However, firefighters were able to suppress the fire before it engulfed the second railcar. EMS responders noted that passengers primarily evacuated themselves from the wreckage, assisting one another as needed. EMS responders primarily helped move passengers away from the burning train to the triage area.

Metro-North conducted a postincident debriefing, as required by federal regulations, and cofacilitated an after-action debriefing for emergency responders.[33] As a result of this debrief, Metro-North and the MTA drafted job aids for personnel tasked with coordinating postaccident family assistance activities. NTSB's Transportation Disaster Assistance division supported this effort in the form of education and meetings to discuss best practices. NTSB provided a 2-day workshop in New York for Metro-North and the MTA. Additionally, Metro-North staff attended family assistance training at the NTSB Training Center.

## 1.8 Railcar Crashworthiness, Materials, and Fire

### 1.8.1 Third Rail During Collision

During the collision, the third rail from the west side of track 2 first pierced the SUV near the bottom of the left-side rear passenger door, extending through the bottom of the SUV. It then impacted the fuel tank and exited the SUV at the top of the right-side rear wheel. The third rail then moved under the front left side of the lead railcar, Metro-North 4333, beside the train wheels.

At the lead railcar, the third rail was forced between the left-side antiroll vertical link and the truck side frame assembly. (See figure 15.) Investigators found segments of burned third rail cover on top of the truck and the third rail. As the rail continued past the antiroll vertical link, it angled upward and made its first entry into the passenger compartment of the lead railcar, introducing sparks and flaming debris into the railcar, contributing to a fire, which will be discussed in section 1.8.3.

[33] Title 49 *CFR* 239.105 "Debriefing and critique" says, "[E]ach railroad operating passenger train service shall conduct a debriefing and critique session after each passenger train emergency situation or full-scale simulation to determine the effectiveness of its emergency preparedness plan, and shall improve or amend its plan, or both, as appropriate, in accordance with the information developed."

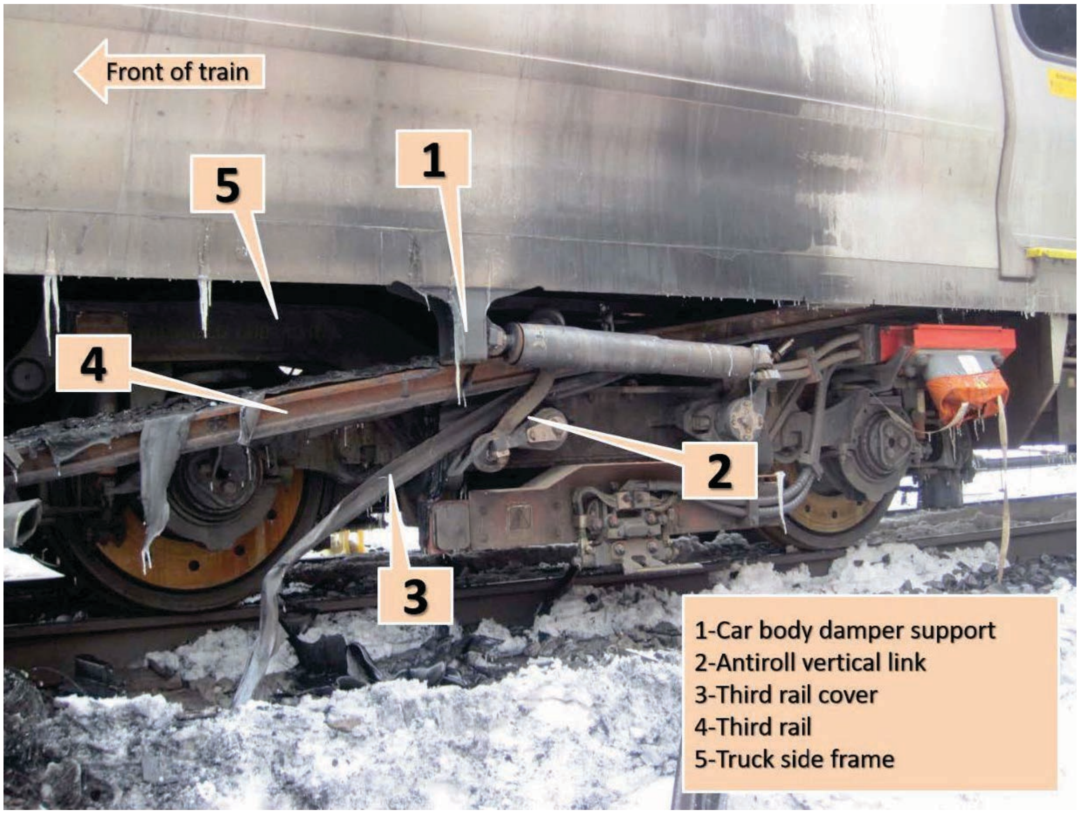


**Figure 15.** Path of the third rail entry into Metro-North 4333.

The third rail entered the lead railcar in two locations. One section of the third rail punctured a hole into the exterior subfloor under the railcar, about 8 feet from the left-side front corner of the car. (See figure 16.) This hole extended through the floor into the passenger compartment. In the interior of the railcar, 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 holds of the second seat row.

The second entry point punctured the railcar's exterior subfloor near the left-side front passenger doorway, about 18 feet from the left-side front corner of the car. The third rail then continued into the interior of the car, under the first row of passenger seats behind the vestibule. Overall, 11 sections of third rail entered the lead railcar and came to rest in the passenger compartment. (See figure 16.)

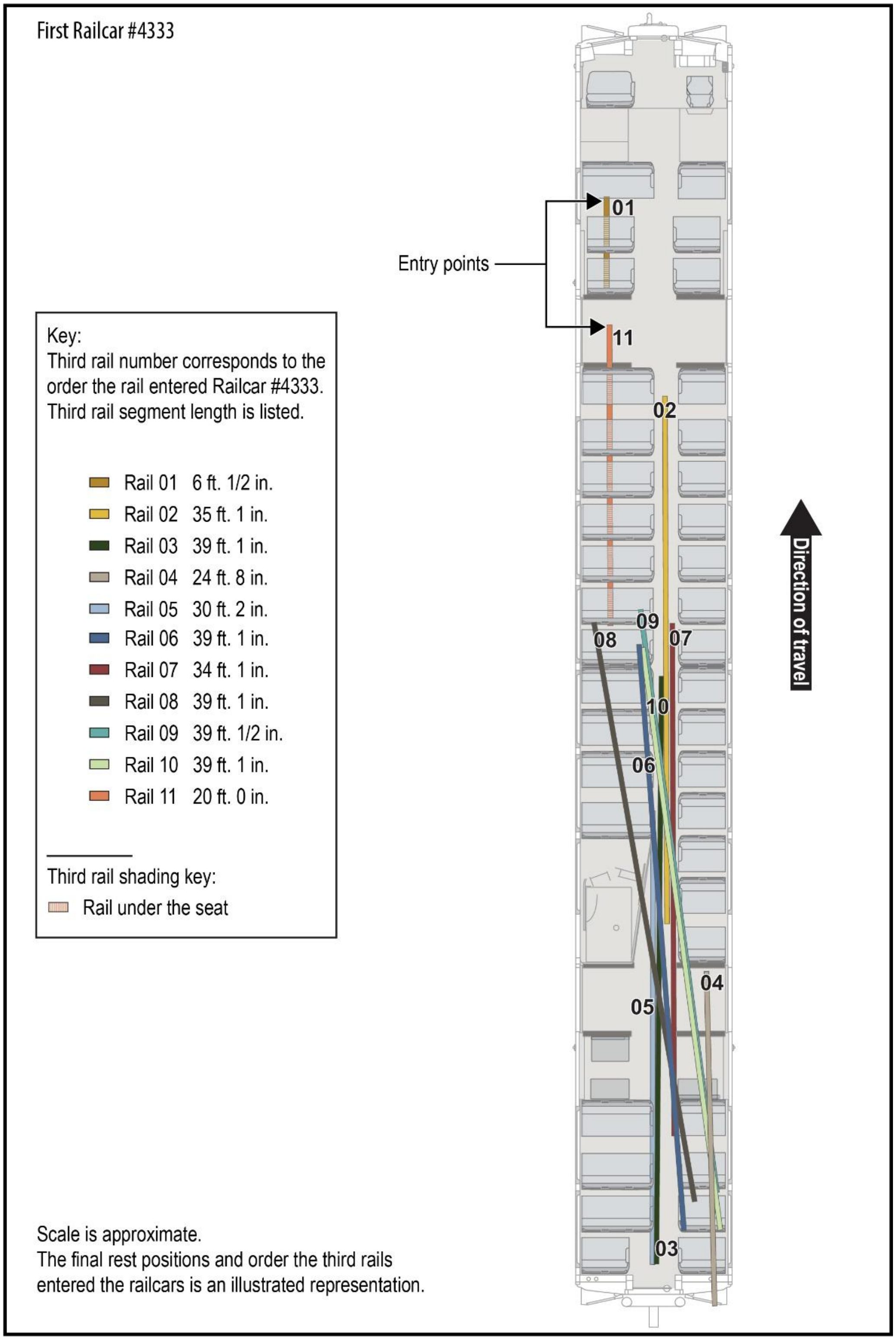


**Figure 16.** Entry points and the approximate position of the third rail inside the lead railcar.

One third rail section pierced through the top right-side rear of the lead railcar and punctured the second railcar, Metro-North 4332. The third rail lodged inside the second railcar between the exterior car body shell and the interior ceiling panels. (See figure 17.)

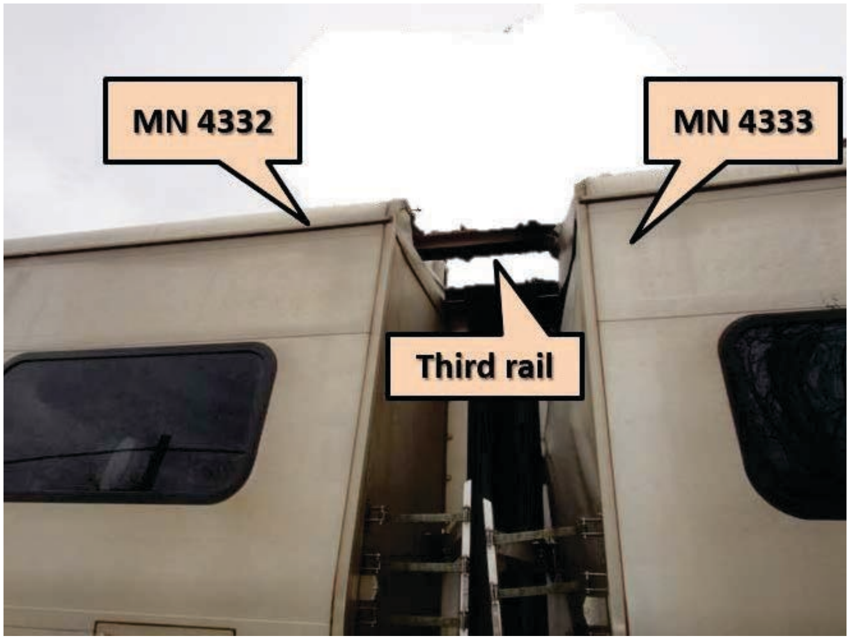


**Figure 17.** Third rail between railcars Metro-North 4332 and 4333.

### 1.8.2 Interior Damage

In the center section of the lead railcar, the left-side seat frames and backs bent toward the rear of the railcar. The right-side seat frames generally were secure in their correct position. Sections of broken overhead baggage racks scattered throughout the car. (See figure 18.) The railcar's rear door was impassible and could not be used because one section of the third rail prevented the door from opening.

**Figure 18.** Interior of the lead railcar, front to rear.

Outside the left side of the lead railcar, investigators found the rear emergency exit window on the ground; however, the accompanying zip strip and window gasket were inside.[34] The second window in the rear section of the railcar was in place, but all remaining windows on the left side of the railcar were melted or missing. The emergency access window from the front side passenger door was found on the ground outside of the railcar, although its exterior zip strip remained in place in the door. The left-side passenger doors would not open, and there was thick soot near the window openings on the left side of the railcar. (See figure 19.)

[34] 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 the emergency removal of the window.

**Figure 19.** Left side of the lead railcar.

Outside the right side of the lead railcar, investigators found a partially melted window on the ground next to the emergency exit window near the front of the train. On the ground outside the center section of the railcar, investigators discovered an emergency exit window and a piece of its zip strip with one emergency pull handle, near the emergency exit window. The other center-section windows were melted or missing, although the right-side rear windows remained in place. Investigators discovered pieces of the rear emergency door release cover on the ground near the door, and both right-side passenger doors were open. There was thick soot on the right side of the railcar near the window openings.

Investigators recovered and examined 11 emergency exit window zip strips (both small single-handled zip strips and large two-handled zip strips) from several of the accident train's windows, which had been opened after the accident, including pieces found from the lead railcar. Investigators found tears of various lengths and depths in nine of them. All of the tears originated from where the emergency pull handles and the zip strip attach. The fracture patterns of the torn zip strips were consistent with overstress. None of the zip strips exhibited visible indicators of age or environmental-related degradation.

### 1.8.3 Materials and Fire

According to statements from witnesses who were passengers in the lead railcar, Metro-North 4333, upon the third rail's intrusion into the car, flaming debris—likely a combination of third rail cover, and components of the train and SUV—and sparks scattered throughout the passenger compartment. The entire lead railcar sustained heavy fire damage.

Investigators collected and examined samples to assess the flammability of materials that made up the interior components of the lead car such as: seat cover upholstery, cushion materials, seat panels, wall panels, light lenses, and the third rail cover.[35]

Due to the amount of damage to the lead railcar, investigators tested interior materials from the second car, Metro-North 4332, to assess the flammability. Title 49 *CFR* Part 238, Appendix B outlines prescribed flammability requirements for interior materials in new passenger railcars, beginning in 2000. These requirements applied to both the lead and second railcars.[36] The flammability of in-service materials is not required by Part 238 to be re-evaluated during the service life of the railcar.

Investigators discovered that three of the material samples from the second railcar no longer complied with the flammability requirements.[37] The testing showed that materials in the passenger seat, including the passenger seat upholstery, the seat back and bottom shell (a single component), and the passenger seat cushion failed to meet the federal standards. The passenger seatback cushion, constructed from a different material than the seat cushion, still complied with the regulation. Witnesses stated that the fires were initially small, did not spread with extreme speed, and did not significantly hinder passengers and crew from exiting the train.

### 1.8.4 Electrical Damage

The railcar structure showed no obvious signs of electrical arcing. Two rails—the nose piece and the rail removed from the SUV—exhibited atypical, localized thermal damage on the surface of the rail. (See figures 20 and 21.)

[35] For a complete list and test results, see NTSB docket DCA15MR006.

[36] Metro-North railcars 4332 and 4333 were a "married pair," which are railcars that are semipermanently coupled together. Bombardier manufactured these railcars in July 2006 at the same time and with similar materials.

[37] Flammability resistance can decrease due to aging and environmental exposure.


**Figure 20.** Localized thermal damage to the third rail nose piece surface removed from the lead railcar.


**Figure 21.** Localized thermal damage to the surface of the third rail removed from the SUV.

# 2. Analysis

## 2.1 Introduction

The NTSB considered the following factors in the investigation of this accident: (1) the performance of the driver, (2) the Metro-North third rail, (3) the flammability of railcar materials, (4) the grade crossing design, (5) the mechanical condition of the train and SUV, (6) the performance of the engineer, (7) environmental factors and weather, (8) the condition of the track, (9) the condition of the railroad signal system, (10) cell phone use by the engineer and the driver at the time of the accident, (11) alcohol or other drug use by the driver and engineer, and (12) the emergency response.

## 2.2 Driver Performance

### 2.2.1 Alcohol or Other Drugs

Following the accident, investigators obtained a postmortem blood sample from the driver and sent it to the FAA's Bioaeronautical Research Sciences Laboratory (an organizational unit within CAMI) for analysis. The analysis, completed on April 8, 2015, showed the driver tested negative for alcohol or other drugs. The NTSB concludes that the driver was not under the influence of alcohol or other drugs at the time of the accident.

### 2.2.2 Medical Factors

According to medical records, the driver was following a medical treatment regimen for hypothyroidism at the time of the accident. According to the driver's spouse, she had successfully managed the symptoms of the condition after being diagnosed several years earlier, with her most common symptom being fatigue. However, she had not complained of being fatigued in the days prior to the accident. The driver's medical records did not indicate any other medical conditions which may have contributed to the collision. The NTSB concludes that the driver had no identified medical condition that contributed to the accident.

### 2.2.3 Fatigue

Information from cell phone records and interviews with her spouse and co-workers formed the basis of investigators' reconstruction of the driver's recent activity history and opportunity for rest. In an interview with investigators, the driver's spouse stated that the driver generally slept well. This table was presented in section 1.2.2.1 and here to show the driver's opportunity for sleep.

**Table 5.** Driver's opportunity for sleep.

| From | | To | | Elapsed Time |
|---|---|---|---|---|
| Date | Time | Date | Time | (approximate) |
| February 1 | 1:27 a.m. | February 1 | 8:45 a.m. | 7 hours 18 minutes |
| February 2 | 12:00 a.m. | February 2 | 9:00 a.m. | 9 hours |
| February 3 | 12:00 a.m. | February 3 | 9:00 a.m. | 9 hours |

Available information on the driver's opportunity for rest shown in table 5 indicates that she had more than 7 hours available for rest in each of the 3 nights prior to the accident and 9 hours available for rest in each of the 2 nights prior to the accident. The driver was not experiencing a chronic or acute sleep debt at the time of the accident. The NTSB concludes the driver was not experiencing performance decrements from chronic or acute fatigue at the time of the accident.

### 2.2.4 Response to Railroad Grade Crossing Warning Systems

The warning systems at the Commerce Street grade crossing consisted of pavement markings, signs, flashing lights, and gates, including eight 12-inch diameter flashing LED light units, and two gate arms mounted on two signal masts; however, it did not have bells. An FRA literature review, focusing on driver behavior at grade crossings, found that drivers do not always understand the distinction between a crossbuck and an advance warning sign. (FRA 2008) Drivers are generally aware that they are approaching a grade crossing; however, drivers do not always understand what actions they should take upon encountering one.

Based on available evidence, it was likely a traffic queue formed prior to the SUV approaching the Commerce Street grade crossing. As the traffic moved toward the grade crossing, the driver encountered a reflectorized grade crossing pavement marking symbol located in the through lane, a grade crossing advance warning sign, a "Do Not Stop on Tracks" sign, and was in clear view of a grade crossing warning crossbuck indicating two tracks. According to a witness, the SUV stopped within the boundary of the crossing prior to the warning devices activating. The flashing red lights on the signal masts and the red lights on the lowering gate arms later activated, indicating that the grade crossing warning system was active, which the driver should have observed. According to the witness, the gate arm lowered and contacted the rear of the SUV while it was stopped past the reflectorized stop line within the boundary of the grade crossing. The witness stated that in response to the gate arm striking her vehicle, the driver exited the vehicle, slowly walked to the rear of the SUV, and touched the gate arm. He characterized the driver's behavior as calm and presumed it was because the SUV was not on the track.

The witness said the driver turned and made eye contact with him after examining the gate arm on the rear of the SUV. The witness said the driver entered her vehicle and that he expected the SUV to back up; however, after a slight pause, the SUV moved forward on to the tracks. Despite the flashing red lights and the lowered gate arm, the driver appeared not to have realized the train was approaching. The NTSB concludes the SUV driver, for undetermined reasons, did not comply with the advance warning system at the Commerce Street grade crossing; stopped past the stop line within the boundary of the grade crossing; and moved on to the tracks.

Although the witness attempted to signal the driver to back up and clear the grade crossing, the driver did not follow his signal. The gate arm striking the SUV likely diverted the driver's attention.

The driver's decision to exit her vehicle to examine the gate arm suggests that she was distracted by it, rather than being concerned about being within the boundary of the grade crossing. According to the witness, when the driver exited her vehicle, she calmly walked to the rear of the vehicle and appeared to assess the vehicle for damage. This focus likely consumed her attention; hindering her ability to detect, perceive, and respond to audible and visual cues that the train was approaching. The NTSB concludes that after the grade crossing activated, the driver's attention was most likely diverted to the crossing gate arm striking her vehicle, and she was unaware of the proximity of the approaching train.

### 2.2.5 Train Warning Devices

Train 659 had visual devices and audible devices, such as active alerting lights and a horn, to alert the driver of its approach.

#### 2.2.5.1 Visual Devices

The lead railcar of the accident train had an external active alerting light system (auxiliary lights) to warn drivers as it approached grade crossings, as required by the FRA.[38] Investigators could not perform postaccident testing on the system because it was destroyed during the accident and fire. In an interview with investigators, the engineer stated that the crew performed all required predeparture equipment tests on the day of the accident and found no problems with the equipment.

As train 659 approached the Commerce Street grade crossing, the driver exited her SUV and walked to the rear of the vehicle where the gate arm was resting. From this position, given the angle between the road and the tracks, the likelihood that the driver would see the train would be substantially reduced as both the SUV and a building to the southeast (substation B26) were between her and the approaching train, limiting her sight distance. As she re-entered her vehicle, it is uncertain if ambient lighting from surrounding traffic, perimeter lighting from a nearby building, and the headlamps from her own vehicle and those behind her may have diminished her ability to detect the lights from the approaching train.

#### 2.2.5.2 Audible Devices

As mentioned in section 1.4.3.2, investigators completed a sound study at the Commerce Street grade crossing to assess the audibility of a typical Metro-North train horn from inside and outside an exemplar Mercedes Benz ML350 SUV. The results of the study showed a measurable increase in sound levels inside the SUV beginning when the train was 350 feet from the crossing compared to ambient sound levels inside the SUV.

The results further showed that sound levels averaged 93.5 dB when a train was 100 feet from the crossing, and 50.5 dB greater than ambient sound levels inside the SUV. Research has shown that under ideal listening conditions, train horn sounds may be detected at thresholds as low

[38] See 49 *CFR* 229.125 for more information.

as 10 dB below the levels of vehicle interior noise. (Dolan and Rainey 2005) A 1999 FRA report indicated that horn detection thresholds could range from –1 to +9 dB, depending upon whether a motorist anticipated encountering a train at a crossing. (FRA 1999)

According to the International Organization for Standardization, standard 7731:1986(E), to ensure audibility under adverse conditions, it is recommended that an auditory signal level exceed masked threshold levels by 13 dB. (International Organization for Standardization 2003) Based on these results, an individual inside a Mercedes Benz ML350 SUV could have heard the sounds of the horn approaching the grade crossing beginning when a train was 350 feet, or about 4 seconds, from the grade crossing. The use of the vehicle's heater or radio was not factored into the study; therefore, the car configuration was assumed to be a best-case scenario for a driver to detect the horn. The NTSB concludes that the sound of a Metro-North train horn was audible from inside an exemplar 2011 Mercedes Benz ML350 SUV when a train was 350 feet from the Commerce Street grade crossing.

### 2.2.6 Vehicle Familiarity

Investigators considered whether the driver could have unintentionally placed the SUV in a forward gear, causing the vehicle to unexpectedly move forward at the grade crossing. Investigators obtained information regarding the driver's experience operating the vehicle, reviewed vehicle recalls or defects, and examined the electronic gear-selection lever in an exemplar 2011 Mercedes Benz ML350 SUV.

In his interview with investigators, the driver's spouse stated that his wife previously drove a Honda vehicle, which had a traditional gear-selection lever. When asked about the driver's experience with the 2011 Mercedes Benz ML350 SUV, he said that she liked driving it and had not complained of any difficulties in using the gear-selection lever. He further stated that he had also driven the vehicle on several occasions and had not experienced any difficulties in using the gear-selection lever. In an interview with investigators, the driver's spouse said, "You want to go forward, you push the gear down; you want to go backwards, you push the gear up."

NHTSA's safety database showed no issues or recalls related to the SUV's gear-selection lever. (NHTSA 2017) Additionally, NHTSA's ODI listed no complaints or open investigations related to the operation of the electronic gear-selection lever for the 2011 Mercedes Benz ML350. (ODI 2017)

Upon examining the exemplar vehicle, NTSB investigators noted that the gear-selection lever is electronically activated from a central position. Selecting a gear position does not have the feel of manipulating a mechanical gear-selection lever, and the actions required to select reverse or forward movement are up for reverse and down for forward. Column-style gear-selection levers require a downward movement to shift from park to reverse and further downward movement to select drive. The driver's previous vehicle had a floor-style gear-selection lever, which had similar movements with a column-style gear-selection lever.

Based upon the interview with the driver's spouse, the examination of the operational characteristics of the exemplar vehicle, and the absence of safety recalls and user complaints in the ODI, investigators could not determine if any factors regarding the driver's familiarity with the operation of the SUV caused her to inadvertently select forward instead of reverse while on the grade crossing. The NTSB concludes there was insufficient evidence to determine if the driver's familiarity with the operation of the SUV caused an inadvertent or unintentional movement forward at the Commerce Street grade crossing.

### 2.2.7 Navigation Systems

The driver's spouse told investigators that there was a global positioning device (GPS) built into the SUV, but he wasn't sure if the driver used it. Although the NTSB could not determine if the driver in the Valhalla accident was using a navigation system, had she been using one with cues for grade crossings, it may have alerted her of the upcoming grade crossing and it could have provided an opportunity to prevent this accident.

In its investigation of a February 24, 2015, passenger train collision with a highway vehicle at a grade crossing in Oxnard, California, the NTSB made a recommendation to Google, Apple, Garmin Ltd., HERE, TomTom NV, INRIX, MapQuest, Microsoft Corporation, Omnitracs LLC, OpenStreetMap US, Sensys Networks, StreetLight Data, Inc., Teletrac, Inc., and United Parcel Service of America, Inc.:

> Incorporate grade crossing-related geographic data, such as those currently being prepared by the Federal Railroad Administration, into your navigation applications to provide road users with additional safety cues and to reduce the likelihood of crashes at or near public or private grade crossings. (H-16-15)

The FRA, in June 2015 announced that Google agreed to integrate FRA-supplied geographic information system (GIS) data on 250,000 public and private grade crossings into its mapping and navigation applications, thereby providing drivers and passengers with additional cues when approaching a grade crossing. (DOT 2015) The FRA indicated that it continues to invite other technology companies to follow suit.[39] As posted on the FRA website, "For drivers and passengers who are driving an unfamiliar route, traveling at night, or who lose situational awareness at any given moment, receiving an additional alert about an upcoming [grade] crossing could save lives." (FRA 2015)

In April 2016, the FRA informed the NTSB that Apple, Garmin, HERE, and TomTom had also agreed to incorporate grade crossing GIS data into their navigation applications; however, a number of the companies indicated that they were uncertain when they would be able to do so because other projects held higher priority. In June 2017, the FRA informed the NTSB that it was reviewing its grade crossing data for accuracy, and it expects to have the data ready for integration into mapping and navigation applications in the Fall of 2017.

[39] The FRA has also consulted with INRIX, MapQuest, Microsoft Corporation, Omnitracs, OpenStreetMap US, Sensys Networks, StreetLight Data, Teletrac, and United Parcel Service of America to discuss integrating grade crossing information into their mapping and navigation applications.

## 2.3 Metro-North Railroad Third Rail

### 2.3.1 Power Control

As the sections of third rail separated during the accident, they were no longer connected to the power source. Investigators were unable to determine exactly when the third rail segments separated; but available evidence indicates the rails separated after entering the lead railcar.

At 6:27:02 p.m., the power director's office sent an open (power off) command for the circuit breaker at substation B29 for track 2 south. At 6:27:50 p.m., 1 minute and 29 seconds after substation B26 detected the first fault, staff in the power director's office sent an open (power off) command for the circuit breaker at substation B26 controlling the power to the third rail on track 2 north. This de-energized the electrical power between the east portion of the third rail and the last four cars of train 659. The NTSB concludes that power controller commands de-energized the electrical power to substations B26 and B29 in a timely manner following the collision. The NTSB further concludes the power controller completed the emergency power shutdown in a manner such that electrical power did not cause or contribute to injuries to the emergency responders or the train evacuees.

### 2.3.2 Third Rail Structure

The third rail nose piece is a 6-foot section of tapered rail attached at the ends of the regular third rails to smoothly transition the current collector shoes from the trains on to the third rail. (See figure 22.) This section of the third rail was the first part to puncture the lead railcar's underside structure and enter the passenger compartment.


**Figure 22.** Third rail nose piece involved in this accident.

During postaccident examinations of recovered third rail sections from inside the lead railcar, investigators observed fractures in the splice bars and bolts that joined the third rail together, but found the third rail sections themselves to be intact and unbroken.

Based on the Metro-North power director's belief that the third rail system was designed to break away from trains during specific types of accidents, investigators obtained design specifications for the third rail structure. With this information, the NTSB then used a computer-based simulation tool called finite element modeling to investigate Metro-North's third rail system and the splice bars in order to understand the mechanical behavior under specific loading conditions. To accomplish this, investigators constructed a three-dimensional finite element model of the third rail assembly based upon Metro-North's drawings, and applied hypothetical loads and boundary conditions simulating deformations that may have occurred during the accident. The study focused on the potential failure modes of the assembly under applied loads.

The model considered two modes of deformation: in-plane (up-and-down) and out-of-plane (side-to-side) bending. (See figure 23.) Investigators chose these modes based on the entry path of the third rail into the lead railcar during this accident. Figure 23 shows the finite element model of the third rail, splice bar, and bolts demonstrating in-plane bending.

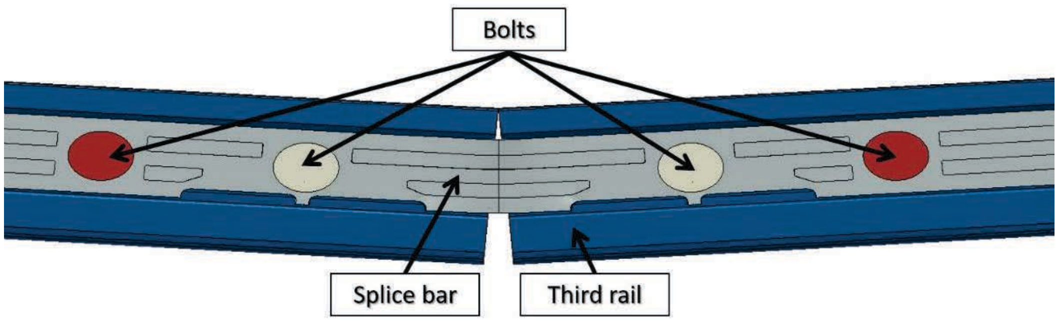


**Figure 23.** Illustration of third rail and splice bar subjected to in-plane bending.

In both analyses, investigators used compressive loads to simulate the forces the SUV and the train exerted on the rail and splice bar assemblies during the accident. The analyses showed Metro-North's third rail splice bar system would have undergone large deformations before failing.

Breakaway designs are constructed to fail at predetermined locations without requiring large deformations in mechanically overloaded situations to protect surrounding systems or equipment. The analyses showed that Metro-North's third rail system did not have any breakaway mechanisms. In this accident, the third rail was first longitudinally loaded in compression, then subjected to both in-plane and out-of-plane bending during the collision sequence. The joined ends or splice bars were not subjected to in-plane and out-of-plane bending until they were inside the lead railcar. Once inside the lead railcar, the third rail splice bars underwent large deformations before fracturing or causing fracture of the attachment bolts. The NTSB concludes that Metro-North's third rail system was not constructed to fail in a controlled manner or break away when subjected to undesirable overloaded conditions such as those involved in this accident.

Of the 11 sections of third rail recovered, five were about 39 feet in length, and each of them weighed nearly 2,000 pounds. In this accident, the third rail overwhelmed the structural elements of the railcar's understructure.

The NTSB has investigated passenger railcar strength in other railroad accidents and has made safety recommendations to improve railcar crashworthiness. Crashworthiness research and improvements specific to railcar strength have focused on the ends of the railcars because they have been the primary locations of failure in collisions and crossing accidents. Rarely do rails intrude through the floor into passenger compartments. This accident demonstrated that Metro-North's third rail assembly catastrophically compromised a passenger railcar with fatal consequences. Metro-North's third rail system penetrated the passenger compartment and broke apart at the splice bars. The third rail entering the lead railcar caused significant damage and increased the number and severity of injuries and fatalities.

The NTSB concludes that the continued use of Metro-North's current third rail system (which lacks controlled failure mechanisms) may increase the severity of railcar damage and serious injuries when accidents occur at or near grade crossings. The NTSB recommends that Metro-North conduct a risk assessment for all grade crossings that have third rail systems present at or near those grade crossings and implement corrections based on its risk assessment findings that will mitigate the risk of grade crossing accident severity. The NTSB acknowledges the efforts that Metro-North and the MTA have initiated to assess and remediate risk at some grade crossings; however, a thorough and more comprehensive assessment is necessary. (See section 3.3 below.)

The NTSB recognizes that other commuter railroads and rail transit properties with grade crossings have third rail systems that could pose similar risks. Therefore, the NTSB concludes that the presence of third rail systems at or near grade crossings on commuter railroads and rail transit properties could increase the severity of grade crossing accidents. Therefore, the NTSB recommends that the LIRR, Amtrak, PATH, and SEPTA conduct a risk assessment for all grade crossings that have third rail systems present at or near those grade crossings and implement corrections based on their risk assessment findings that will mitigate the risk of grade crossing accident severity.

The NTSB further recommends that the Federal Transit Administration (FTA) notify all rail transit properties that have third rail systems at or near grade crossings about this accident and advise them to conduct a risk assessment for all grade crossings that have third rail systems present at or near those grade crossings. The NTSB also recommends that after a full risk assessment is complete, the FTA require all rail transit properties to implement corrections based on their findings that will mitigate the risk of grade crossing accident severity.

## 2.4 Materials, Flammability, and Evacuation

The SUV and train 659 moved about 250 feet north after the collision, before the third rail from the west side of track 2 punctured the SUV near the bottom of its left-side rear door. The rail continued through the bottom of the SUV and impacted the fuel tank, exiting at the top of the right-side rear wheel. The third rail then entered the left side of the leading railcar, Metro-North 4333. The SUV and the train then continued to move about 415 feet before stopping. According to the engineer, the cab compartment quickly filled with smoke. When he exited the cab, he saw a significant amount of fire in the center and rear of the passenger area. He described the fire as moving toward the front of the railcar. The engineer and passengers described the initial fire in the railcar to investigators as multiple spot fires and dripping flames within the center of the passenger compartment.

NTSB investigators analyzed the materials that could have contributed to the multiple spot fires in the lead railcar. During the accident sequence, the third rail punctured the SUV's fuel tank. Once the third rail entered the lead railcar, gasoline from the SUV's fuel tank transferred to the third rail cover, made of a type of polymer. During postaccident examination of the railcar, investigators found pieces of fire-damaged third rail cover on the third rail and in the lead railcar. The sections of the third rail cover ignited and burned.

During the crash sequence, eleven sections of the third rail penetrated the lead railcar floor and came to rest inside the passenger compartment. Witnesses in the lead railcar told investigators that upon the third rail entering the passenger compartment, they saw sparks and flaming debris—which is consistent with a combination of fragments from the third rail cover, train components, and SUV components, including fuel—scattering throughout the passenger compartment spreading fire.

The NTSB concludes that the introduction of sparks, flaming debris, and fuel into the lead railcar was the source of ignition and multiple areas of ignition contributed to the spread of a postaccident fire.

The amount of the third rail and its location within the lead railcar impeded some passengers' ability to evacuate Metro-North 4333. A section of third rail blocked the rear door, preventing its use as an exit. Passengers in the center and the rear of the car would have had to climb over sections of the third rail to access the side doors. Furthermore, a postaccident fire was developing. Witnesses stated that the fires were initially small, did not spread with significant speed, and did not significantly hinder their exit from the train. Passengers reported they used the closest accessible exits. The left-side doors were damaged, so passengers used emergency window exits on both sides of the car and the right-side front door to evacuate the car.

According to statements from passengers who survived the intrusion of the third rail, some passengers on the right side of the center section of the lead railcar egressed through an emergency window exit. Passengers in the back of the car used the left-side rear emergency window exit to vacate the lead railcar. The NTSB concludes that the emergency window exits that passengers used on the left side of the lead railcar functioned as designed, and there likely would have been more serious injuries due to the fire and smoke had these exits not functioned properly.

## 2.5 Highway-Railroad Grade Crossing Warning System

The Metro-North Railroad was responsible for the inspection, testing, and maintenance of the Commerce Street grade crossing warning system. Investigators examined and tested it, including the flashing lights and gate arms. Railroad maintenance and inspection records for the Commerce Street grade crossing warning system did not indicate a history of activation failures. Testing conducted after the accident determined that the gate control circuit was functioning properly, and the electromechanical relay for that circuit functioned normally.

According to the downloaded grade crossing data, the warning system detected the presence of the train at 6:25:38 p.m. About 4 seconds later, the crossing control relay was de-energized, which then de-energized and opened both gate motor control relays. The open gate motor control relays removed power from the gate hold-clear mechanism and released the gates. The gate arms reached their full horizontal position about 13 seconds after the flashing light units activated. The NTSB investigation did not identify any fault that would have caused a delay or failure in the lowering of either of the crossing gate arms at the Commerce Street grade crossing. Investigators determined the LED units installed for the warning system at the Commerce Street grade crossing were intact and operational and found the lighting circuit voltages for both signal masts and gate arm lights to be in compliance with federal regulations. Postaccident tests determined the flashing light units operated at 44 flashes per minute, which was within design specifications and regulatory requirements.

Investigators determined the train detection track circuits were of sufficient length to provide a minimum of 35 seconds of warning time for trains traveling in both directions and on either track at the maximum authorized speed of 60 mph. Postaccident testing of the warning system found no evidence of a failure in the electronic or electromechanical components of the system. The data logger for the warning system indicated the warning system provided 39 seconds of warning time.[40] The data logger operated within equipment manufacturer specifications, which allowed investigators to determine that the warning system data were recorded accurately.

The FRA regulations found in 49 *CFR* Part 234 "Grade Crossing Safety," the federal *Manual on Uniform Traffic Control Devices* (MUTCD), and the *New York State Supplement* to the *Manual on Uniform Traffic Control Devices* (NYS MUTCD) comprise the specifications for a uniform system of traffic control devices, including grade crossing warning systems, within the state of New York. (State of New York Department of Transportation [NYSDOT] 2009)[41] The NTSB concludes that the grade crossing warning system on Metro-North at Commerce Street functioned as designed when the accident occurred and met federal and state requirements.

The investigation determined that the grade crossing warning system preemption circuit in the Metro-North signal case was properly configured and it functioned as designed.[42] Activating the warning system transmitted the correct signal to the highway traffic signals to initiate the railroad preemption sequence phase. The NTSB concludes that the Metro-North grade crossing warning system preemption circuit was properly configured and it functioned as designed.

Without a recording device capable of monitoring both the railroad warning system and the traffic signal operation, investigators could not determine which preemption (Preemption #1 or Preemption #2) was active at the time of the accident. However, when asked about traffic in front of the SUV on Commerce Street in the moments before the collision, the engineer said that "there was nothing in front of her," and the driver of the SUV could have proceeded forward. The engineer's statement suggests that Preemption #2 influenced the northeast approach of Commerce Street, thus providing time with a green traffic signal for vehicles traveling northeast on Commerce Street to clear the grade crossing. (See section 3.1, for more information on the preemption of the traffic signal and postaccident actions.)

[40] The warning time of 39 seconds was due to the train's reduction in speed.

[41] Some of the specifications found in the MUTCD and NYS MUTCD are requirements, and are indicated as such by the use of the word "standard", while others are regarded as guidelines or suggestions by the use of the words "guidance", "option", and "support".

[42] The preemption of a highway traffic signal requires an electrical circuit between the control device of the railroad's grade crossing warning system and the controller assembly of the highway department's traffic signal. The railroad is only responsible for the maintenance and testing of its interconnections.

## 2.6 Factors Not Contributing to this Accident

The NTSB determined that the factors described in this section did not contribute to the accident.

Postaccident inspections of the train and the SUV did not disclose any defective mechanical condition that contributed to the accident. The driver had properly registered the SUV with the state of New York and it had recently passed the required annual safety inspection. The train's event recorder showed that the engineer operated the train at 1 mph below the maximum authorized speed for the territory and sounded the train horn within the required 15-20 seconds prior to arrival at the Commerce Street grade crossing. There was no precipitation at the time of the accident and the road had been recently plowed for snow removal.

Postaccident inspections of the railroad track and the railroad signal systems revealed that Metro-North had maintained the systems properly and they were performing within their prescribed requirements. The engineer had rested longer than the minimum 8-hour rest period for at least 3 days prior to the accident, and had a rest period in excess of 23 hours prior to going to work the day of the accident. The engineer tested negative for alcohol or other drugs.

Cell phone records indicate the engineer was not using his cell phone at the time of the accident, and the driver's last call ended 6 minutes before the accident.

The NTSB concludes that none of the following were factors that contributed to this accident: (1) the mechanical condition of the train or SUV, (2) the engineer's performance, (3) environmental factors and weather, (4) the condition of the track, (5) the condition of the railroad signal system, (6) fatigue of the engineer, (7) cell phone use while operating the train or SUV, and (8) the use of alcohol or other drugs by the engineer.

# 3. Postaccident Actions

## 3.1 Highway Traffic Signal Preemption

During postaccident examinations of the traffic signal preemption system, NTSB investigators identified a circumstance in which the traffic signal preemptive order did not comply with federal requirements outlined in the 2009 MUTCD. At the accident location, Preemption #2 (activated by the railroad train detection circuit) did not receive priority over Preemption #1 (activated by highway traffic) when Preemption #1 was already active. According to the MUTCD, "when multiple or successive preemptions occur, train activation shall receive first priority." (Federal Highway Administration [FHWA] 2009) Although the preemptive order did not follow the MUTCD, NTSB investigators found that it did not contribute to the accident.

After the accident, on May 1, 2015, the NYSDOT adjusted the traffic signal preemption at the Commerce Street and Taconic State Parkway intersection to ensure railroad preemption is the highest priority and that successive preemptions cannot interrupt the railroad preemption. Further, the NYSDOT inspected and confirmed all traffic signals with railroad preemption in Region 8 met the requirements of the 2009 MUTCD, ensuring railroad preemption is the highest priority at all intersections.[43]

The NYSDOT expanded the improvement program to include all traffic signals with railroad preemption for the remaining regions in the state, to ensure that all of the intersections met the 2009 MUTCD requirements and that railroad preemption is the highest priority.

Additionally, the FHWA sent an *Information and Action Bulletin* to all FHWA division offices notifying them of this accident, and of the 2009 MUTCD requirement that "when multiple or successive preemptions occur, train activation shall receive the highest priority." (FHWA 2009)

While adjusting the traffic signal preemption, the NYSDOT also adjusted the clearance time for vehicles traveling northeast on Commerce Street under Preemption #2. NYSDOT changed the clearance time from its range of 2 to 10 seconds—which was in effect at the time of the accident—to 29 seconds of clearance time, followed by 4 seconds of yellow. This change, according to NYSDOT, was calculated using the "Guide for Determining Time Requirements for Traffic Signal Preemption at Highway-Rail Grade Crossings" contained in the *August 2007 Railroad-Highway Grade Crossing Handbook*. (FHWA 2007) This guideline uses an intermediate semi-trailer, serving as a "worst-case vehicle" to assess the time it would take to move from a stopped position on the far side of the crossing, clear the tracks, and proceed through the intersection.[44]

The interconnection for the traffic signal preemption was installed on October 27, 2008, and at that time the NYDOT determined that a range of 2 to 10 seconds as the clearance time at

[43] Region 8 is one of 11 geographically defined regions in the state of New York, and is the region in which this accident occurred.

[44] An *intermediate semi-trailer* has five axles. The intermediate semi-trailer was chosen as a "worst-case vehicle" because it is presumed that it would take the longest amount of time to move through the crossing.

the grade crossing was appropriate. Although guidance documents were available in the *August 2007 Railroad-Highway Grade Crossing Handbook*, it does not appear that NYSDOT used them to establish the clearance time. When questioned by NTSB investigators, NYSDOT staff could not explain how the preemption timing range was determined at that time, nor could they identify what guidance, if any, was used when making that decision.[45]

The NYSDOT identified another traffic signal in Region 8 that is "similar" to the one at Taconic State Parkway and Commerce Street that has a maximum clearance time of 10 seconds. The traffic signal is located at River Road and Global Terminal in New Windsor, New York. The NYSDOT is currently examining whether grade crossings with preempted traffic signals at intersections in the state's other regions have the 10-second maximum clearance time. The NTSB concludes the NYSDOT should assess the intersections in its regions near grade crossings with preempted traffic signals to determine whether timing adjustments are established based on engineering principles or current industry guidance. The NTSB recommends that once the NYSDOT completes an assessment in its regions at intersections near grade crossings with preemptive traffic signals, it proceed with making any necessary adjustments based on engineering principles and current industry guidance.

## 3.2 Closure of Commerce Street Grade Crossing

As a result of this accident, the town of Mount Pleasant conducted a volume, speed, and vehicle-classification count study on Commerce Street, just south of the grade crossing. The town used the results of this study to determine the feasibility of closing the Commerce Street grade crossing.

A town of Mount Pleasant official told investigators they are preparing an internal report that will describe the town's grade crossings in relation to their attributes, noted deficiencies, and traffic volumes. The official added that the report would likely recommend that the Town Board petition the state of New York to close of the Commerce Street and Cleveland Avenue grade crossings.[46]

### 3.2.1 Guidance Regarding the Closure of Grade Crossings

In the state of New York, the commissioner of transportation has the authority to order the elimination of grade crossings. According to the listing for New York in "Appendix H: State

[45] States can establish their own policies for setting maximum clearance time for preempted traffic signals near grade crossings. Resources available for states to establish preemption timing for traffic signals include: "Guide for Determining Time Requirements for Traffic Signal Preemption at Highway-Rail Grade Crossings" contained in the August 2007 *Railroad-Highway Grade Crossing Handbook*, establishing a standard practice based on the field measurements and critical intersection data. Some examples of state guidance include the *Texas Rail-Highway Operations Manual* (State of Texas Department of Transportation [TDOT] 2015) and *Preempting Traffic Signals near Railroad Crossings in Utah* (State of Utah Department of Transportation [UDOT] 2017). The state of Ohio has guidance in several related manuals, including the *Traffic Engineering Manual* (State of Ohio Department of Transportation [ODOT] 2016) and the *Ohio Manual of Uniform Traffic Control Devices*. (ODOT 2012)

[46] On April 14, 2016, a spokesperson for the town of Mount Pleasant indicated to investigators that the town will wait for the release of the findings and recommendations of this investigation before presenting any findings and recommendations to the Town Board regarding the potential closing of the grade crossings.

Crossing Consolidations and Closures" from the revised second edition of FHWA's *Railroad-Highway Grade Crossing Handbook*:

> Any railroad company or governing body of a municipality that contains a highway-rail crossing can petition the commissioner to institute grade crossing elimination procedures.
>
> The commissioner may hold public hearings on any elimination requested by petition after giving due notice to the parties in interest. At the conclusion of the hearing, the commissioner shall, by order, determine whether it is in the public interest to require the elimination of the highway-rail grade crossing. In any elimination order, the procedures for elimination are to be specified. (FHWA 2007)[47]

The following is an excerpt from NYSDOT's guidance regarding the closure of grade crossings:

> Ultimately, the safest option regarding highway-railroad grade crossings is to eliminate or close them, thereby eliminating all possibility of vehicle/train contact. Such an objective can be obtained via crossing consolidation, closure and/or grade separation of the two modes of transportation. Consequently, it has been the policy of New York State to reduce, wherever possible, the number of highway-railroad grade crossings on public thoroughfares. Dozens of highway-railroad grade crossings have been safely and permanently closed under this initiative. (NYSDOT 2017)

The FHWA guidance regarding the closure of crossings is contained in Chapter IV "Identification of Alternatives," Section E "Closure" in the August 2007 *Railroad-Highway Grade Crossing Handbook* which indicates the following:

> Closure of a highway-rail grade crossing to highway traffic should always be considered as an alternative. … Closure of at-grade crossings is normally accomplished by closing the highway. … A study of highway traffic flow should be conducted to determine origin and destination points and needed highway capacity. (FHWA 2007)

The town of Mount Pleasant conducted a study of highway traffic volumes in which it simulated closing the Commerce Street grade crossing to estimate the effect of increased traffic volumes on nearby intersections—primarily, the intersection of Commerce Street and Taconic State Parkway and the intersection of Lakeview Avenue and Taconic State Parkway. Investigators reviewed the results of the town's study, specifically the increased traffic volumes. The study results showed that traffic volumes could be accommodated at both intersections by providing additional highway capacity and readjusting the timing of the traffic signals.

[47] The information in Appendix H is excerpted from New York [Transp.] Law Section 222.

FHWA's *Railroad-Highway Grade Crossing Handbook* provided further information regarding the closure of grade crossings:

> Eliminating redundant and unneeded [grade] crossings should be a high priority. Barring highway or railroad system requirements that require crossing elimination, the decision to close or consolidate [grade] crossings requires balancing public necessity, convenience, and safety. (FHWA 2007)

Table 6 summarizes the distances between several grade crossings in the area near the accident site: Stevens Avenue, Commerce Street, Lakeview Avenue, and Cleveland Avenue, a total distance of about 2 miles. Consolidating the number of grade crossings from four to two would conform to NYSDOT's policy of consolidating grade crossings wherever possible.

**Table 6.** Distances between grade crossings on Metro-North near the accident site.

| Grade crossings listed from north to south | Distance between grade crossings |
|---|---|
| Stevens Avenue to Commerce Street | 3,996 feet |
| Commerce Street to Lakeview Avenue | 1,875 feet |
| Lakeview Avenue to Cleveland Avenue | 4,722 feet |
| **Total Distance** | **10,593 feet (or 2 miles)** |

Additional guidance on grade crossing closures included in the FHWA *Railroad-Highway Grade Crossing Handbook* states:

> Closure criteria vary by locality but typically include train and roadway traffic volume, speed of trains, number of tracks, material being carried, crossing location, visibility, distance to traffic signals, and number of crashes. (FHWA 2007)

Investigators applied data from the town of Mount Pleasant's study on the potential for closing the Commerce Street grade crossing with the "typical" closure criteria outlined above. Table 7 summarizes this information, the results of which supports the closure of the Commerce Street grade crossing.

**Table 7.** Closure criteria data for the Commerce Street grade crossing.

| Closure Criteria | Comment |
|---|---|
| Train volume | **High train volumes:** 107 trains per day (weekday) and 58 trains per day (weekend) |
| Roadway traffic volume | **Low roadway traffic volumes:** 1,024 vehicles per day (535 westbound + 489 eastbound) |
| Speed of trains | **High train speeds:** 60 mph |
| Number of tracks | **More than one track:** 2 tracks |
| Material being carried | **High volume of passengers being carried:** passenger trains |
| Crossing location | **Poor angle of approach:** 64 degrees in eastbound direction looking to the right |
| Visibility | **Poor visibility:** 90 feet in eastbound direction looking to the right. A Metro-North substation is located in the railroad right-of-way that restricts visibility in the eastbound direction looking to the right |
| Distance to traffic signals | **Short distance:** 82 feet |
| Number of crashes | **Two fatal crashes resulting in seven deaths:**<br>February 3, 2015 – 6 deaths<br>October 10, 1984 – 1 death |

The NTSB concludes that the postaccident process taken by the town of Mount Pleasant to recommend closure of the Commerce Street grade crossing complied with NYSDOT and FHWA guidance regarding the closure of grade crossings. The NTSB further concludes closure criteria attributes from the town of Mount Pleasant's study support closure of the Commerce Street highway-railroad grade crossing as outlined in FHWA's August 2007 edition of the *Railroad-Highway Grade Crossing Handbook*. The NTSB recommends that the town of Mount Pleasant take action based on the results of its traffic study and the FHWA August 2007 guidelines to improve grade crossing safety in the town of Mount Pleasant.

## 3.3 Grade Crossing Awareness and Risk Assessment

As a result of this accident, the MTA partnered with Operation Lifesaver to create a safety awareness campaign using a multimedia approach and focusing on grade crossing and right of way safety.[48] Additionally, the MTA has developed a customer-awareness information webpage, in conjunction with Operation Lifesaver, that informs the public on safety issues, including safety at grade crossings. (MTA 2015)

The MTA developed educational media posters regarding grade crossing safety and placed them on 2,400 commuter rail trains, as well as 480 stations. The campaign also featured animated videos and broadcast them on over 24 digital screens at Penn Station, GCT, Jamaica Station, Atlantic Avenue Station, and Fulton Center Station, as well as on social media. The MTA also aired videos on 405 movie theater screens and placed print advertisements in local news publications, as well as online paid advertisements on Facebook, Crain's, New York Business

[48] (a) Operation Lifesaver is a nonprofit public safety education and awareness organization dedicated to reducing collisions, fatalities, and injuries at grade crossings and trespassing on or near railroad tracks. (b) A *right of way* is a type of easement granted or reserved over the land for transportation purposes, this can be for a highway, public footpath, rail transport, canal, as well as electrical transmission lines, and oil and gas pipelines.

online, Newsday, New York Daily News, LoHud, and the Connecticut Media Group to further educate the public in grade crossing safety.


**Figure 24.** Billboard advertising grade crossing safety in Astoria, New York. (Source: Metro-North.)

The MTA and Operation Lifesaver also enhanced the grade crossing safety information that was found in the New York State Drivers Manual and consolidated the information into a chapter on "Special Driving Conditions." (NYSDMV 2017b)

According to the MTA, the partnership with Operation Lifesaver has created more opportunities to enhance education and public awareness programs and bring relevance to urban areas that previously had limited exposure to Operation Lifesaver materials.

The MTAPD has increased its education and enforcement actions with coordinated efforts including local law enforcement. The MTAPD, along with the Metro-North, has developed a Right of Way Task Force to address conditions that may cause safety concerns. As of November 2016, the MTAPD has shared 9,173 educational pamphlets with motorists, covered 1,900 specific grade crossing details, issued 200 summonses and 894 warnings to grade crossing violators, and made 5 arrests.

The MTA engaged the services of a design and engineering firm to assess grade crossing site conditions and coordinate with state and local department of transportation officials to develop action plans to improve site conditions and interaction with traffic control devices across its territory. The MTA continues to work with the national MUTCD technical committee on grade crossings to enhance the MUTCD, and develop tests of new road markings, signage, and lighting to determine their effectiveness on behavior modification at grade crossings. As a result of these efforts, the FRA awarded $1.91 million to the MTA to install cameras to record movements at 43 identified grade crossings within Metro-North territory in New York to investigate specific incidents and analyze grade crossing/traffic operations for targeted modifications to improve safety. (MTA 2016)

# 4. Conclusions

## 4.1 Findings

1 None of the following were factors that contributed to this accident: (1) the mechanical condition of the train or sport-utility vehicle, (2) the engineer's performance, (3) environmental factors and weather, (4) the condition of the track, (5) the condition of the railroad signal system, (6) fatigue of the engineer, (7) cell phone use while operating the train or sport-utility vehicle, and (8) the use of alcohol or other drugs by the engineer.

2 The sport-utility vehicle driver was not under the influence of alcohol or other drugs at the time of the accident.

3 The sport-utility vehicle driver had no identified medical condition which may have contributed to the accident.

4 The sport-utility vehicle driver was not experiencing performance decrements from chronic or acute fatigue at the time of the accident.

5 The sport-utility vehicle driver, for undetermined reasons, did not comply with the advance warning system at the Commerce Street highway-railroad grade crossing; stopped past the stop line within the boundary of the grade crossing; and moved on to the tracks.

6 After the grade crossing activated, the sport-utility vehicle driver's attention was most likely diverted to the crossing gate arm striking her vehicle, and the driver was unaware of the proximity of the approaching train.

7 The sound of a Metro-North Railroad train horn was audible from inside an exemplar 2011 Mercedes Benz ML350 sport-utility vehicle when a train was 350 feet from the Commerce Street highway-railroad grade crossing.

8 There was insufficient evidence to determine if the driver's familiarity with the operation of the sport-utility vehicle caused an inadvertent or unintentional forward movement at the Commerce Street grade crossing.

9 The introduction of sparks, flaming debris, and fuel into the lead railcar was the source of ignition and multiple areas of ignition contributed to the spread of a postaccident fire.

10 The emergency window exits that passengers used on the left side of the lead railcar functioned as designed, and there likely would have been more serious injuries due to the fire and smoke had these exits not functioned properly.

11 The power controller commands de-energized the electrical power to substations B26 and B29 in a timely manner following the collision.

12 The power controller completed the emergency power shutdown in a manner such that electrical power did not cause or contribute to injuries to the emergency responders or the train evacuees.

13 Metro-North Railroad's third rail system was not constructed to fail in a controlled manner or break away when subjected to undesirable overloaded conditions such as those involved in this accident.

14 The continued use of the Metro-North Railroad's current third rail system (which lacks controlled failure mechanisms) may increase the severity of railcar damage and serious injuries when accidents occur at or near grade crossings.

15 The presence of third rail systems at or near highway-railroad grade crossings on commuter railroads and rail transit properties could increase the severity of highway-railroad grade crossing accidents.

16 The highway-railroad grade crossing warning system on the Metro-North Railroad at Commerce Street functioned as designed when the accident occurred and met federal and state requirements.

17 The Metro-North Railroad highway-railroad grade crossing warning system preemption circuit was properly configured and it functioned as designed.

18 The state of New York Department of Transportation should assess the intersections near highway-railroad grade crossings in its regions with preempted traffic signals to determine whether timing adjustments are established based on engineering principles or current industry guidance.

19 The postaccident process taken by the town of Mount Pleasant to recommend closure of the Commerce Street highway-railroad grade crossing complied with the state of New York Department of Transportation and the Federal Highway Administration guidance regarding the closure of highway-railroad grade crossings.

20 The closure criteria attributes from the town of Mount Pleasant's study support closure of the Commerce Street highway-railroad grade crossing, as outlined in the Federal Highway Administration's August 2007 edition of the *Railroad-Highway Grade Crossing Handbook*.

## 4.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the driver of the sport-utility vehicle, for undetermined reasons, moving the vehicle on to the tracks while the Commerce Street highway-railroad grade crossing warning system was activated, into the path of Metro-North Railroad train 659. Contributing to the accident was the driver of the sport-utility vehicle: (1) stopping beyond the stop line, within the boundary of the highway-railroad grade crossing, despite warning signs indicating the approach to the grade crossing; and (2) reducing the available time to clear the grade crossing by exiting the vehicle after the grade crossing warning system activated because the driver's attention was diverted by the grade crossing warning system crossing gate arm striking her vehicle. Contributing to the severity of the accident was the third rail penetrating the passenger compartment of the lead passenger railcar and the postaccident fire.

# 5. Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following new safety recommendations:

**To the Federal Transit Administration:**

Notify all rail transit properties that have third rail systems at or near highway-railroad grade crossings about this accident and advise them to conduct a risk assessment for those highway-railroad grade crossings. (R-17-07)

After a full risk assessment is complete, require all rail transit properties to implement corrections based on their findings that will mitigate the risk of highway-railroad grade crossing accident severity. (R-17-08)

**To the Metro-North Railroad:**

Conduct a risk assessment for all highway-railroad grade crossings that have third rail systems present at or near those highway-railroad grade crossings and implement corrections based on your risk assessment findings that will mitigate the risk of highway-railroad grade crossing accident severity. (R-17-09)

**To the Long Island Rail Road, National Railroad Passenger Corporation, Port Authority Trans-Hudson Corporation, and Southeastern Pennsylvania Transportation Authority:**

Conduct a risk assessment for all highway-railroad grade crossings that have third rail systems present at or near those highway-railroad grade crossings and implement corrections based on your risk assessment findings that will mitigate the risk of highway-railroad grade crossing accident severity. (R-17-10)

**To the state of New York Department of Transportation:**

Once you complete an assessment at intersections in your regions near highway-railroad grade crossings with preemptive traffic signals, proceed with making any necessary adjustments based on engineering principles and current industry guidance. (R-17-11)

**To the town of Mount Pleasant, New York:**

Take action based on the results of your traffic study and the Federal Highway Administration’s August 2007 guidelines to improve grade crossing safety in the town of Mount Pleasant. (R-17-12)

## BY THE NATIONAL TRANSPORTATION SAFETY BOARD

**ROBERT L. SUMWALT, III**
Acting Chairman

**EARL F. WEENER**
Member

**CHRISTOPHER A. HART**
Member

**T. BELLA DINH-ZARR**
Member

**Adopted: July 25, 2017**

Acting Chairman Sumwalt, Member Weener, and Member Dinh-Zarr filed the following statements.

# Board Member Statements

**Acting Chairman Robert L. Sumwalt, III filed the following concurring statement on July 26, 2017.**

When the gavel dropped to begin the Board Meeting for this accident, I suspect some may have had the expectation that the NTSB would be able to explain with certainty why the driver of the SUV ended up on the tracks that fateful evening. Unfortunately, for those of us looking for answers, as I've seen during the past 11 years as a Member of the NTSB, sometimes we can't absolutely explain human behavior – especially when we don't have that person to talk to.

Although not specifically discussed in the report, one explanation I believe is quite plausible is that the driver simply did not realize she was on or near railroad tracks. At first glance, that theory may not seem credible. After all, the grade crossing was denoted by advance warning signs and pavement marking, including a sign along the right side of the road that stated, "DO NOT STOP ON TRACKS." Once the train was 39 seconds from reaching the grade crossing, the gate arm began lowering and, seconds later, struck the rear of her car. Furthermore, there were bi-directional flashing red lights that would have been visible in front of her. So, it's legitimate to ask, "How could she *not* know?"

To answer that in context, the roadway leading up to the accident location was not lighted. "It was really dark," the driver in the car behind her later recounted to investigators. Furthermore, the accident driver was not familiar with this location. She had not originally intended to be on Commerce Street, but traffic had been diverted onto this street due to an earlier nearby traffic crash. As a result, traffic along Commerce Street was reported to be "inching along," according to the driver behind her. Anyone who has driven in such conditions can relate to how a driver's focus can simply narrow to following the car in front of you. When that car stops, you stop. When that car moves a few feet, you move. Stop and go. Stop and go. Stop and go. Your focus can become mesmerized with mimicking the movements of the vehicle creeping along in front of you.

The driver in the vehicle behind the accident SUV offers an account that lends credence to this theory. Explaining that he is usually well-aware of his situation, he told investigators:

> I'm aware—and even I wasn't aware I was that close to those crossing gates. … I don't know if because I was driving slow and we were just inching along—or I didn't expect it, but it was dark and that's—that's what sticks out now, that I didn't think I was that close to the tracks…. I think that could have been me up in there. And, I would have went [*sic*] through the gate, but it was just that kind of situation where because you were inching slow and wasn't—I wasn't paying attention. Normally, I do.

My belief that the driver was not aware she was anywhere near a railroad track is further bolstered by her actions and demeanor after the gate arm struck her car. She got out of her car and calmly walked to the car's rear to see what had struck it, according to the witness. He recounted to investigators that "she was not hurried at all" and that she did not seem at all panicked. According to the witness, she touched the gate arm that was resting on the rear of her vehicle, as if she wasn't sure what it was. She then returned to get back into her vehicle, paused a few seconds, as if she were taking time to fasten her seatbelt, and then proceeded forward. That's when she was struck by the train.

Someone in a good state of mind, as this driver apparently was, who is aware that they are in close proximity to a railroad crossing, and in imminent danger of being struck by a train going 60 mph, would not act this way.

In summary, I believe the driver of the SUV was *not* aware she was located perilously close to railroad tracks on that fateful evening. If she were aware, and had she responded appropriately, this tragedy would have been avoided.

One way to heighten awareness of proximity to railroad crossings was highlighted in the NTSB's investigation of a highway-railroad grade crossing accident that happened three weeks after the tragedy at Valhalla. In that accident, the driver of a pick-up truck inadvertently turned onto railroad tracks and drove his car about 80 feet before becoming stuck. Shortly after he abandoned his vehicle a commuter train stuck the vehicle and derailed several cars. The engineer of the train lost his life. Following that accident, the NTSB issued the following recommendation to several electronics manufacturers, including Google, Apple, and Garmin:

> Incorporate grade-crossing related geographic data, such as those currently being prepared by the Federal Railroad Administration, into your navigation applications to provide road users with additional safety cues and to reduce the likelihood of crashes at or near public or private grade crossings. (H-16-15)

The Federal Railroad Administration has also pushed for such enhancements, stating: "For drivers and passengers who are driving an unfamiliar route, traveling at night, or who lose situational awareness at any given movement, receiving an additional alert about an upcoming [grade] crossing could save lives."

I hope this recommendation can be complied with soon, as well as those that were issued in the Valhalla report. Only then can we rest easier by knowing that tragedies such as that in Valhalla can be avoided.

**Member T. Bella Dinh-Zarr filed the following concurring statement on August 1, 2017**

This extremely thorough investigation conducted by a multi-modal NTSB investigative team once again highlights what the NTSB does best—preventing injuries and saving lives. Yet this accident, like so many that we investigate across all modes, was especially difficult and challenging because the one person we all wanted to interview—the SUV driver—was killed in the accident. At the scene of an accident, the NTSB tells the news media that our objective is not just to find what happened but *why* it happened, so we can make recommendations to ensure it does not happen again. We emphasize that the NTSB is an investigative agency that examines factual evidence and that we will not speculate about what may have caused an accident.

The nature and circumstances of this particular accident make it so tempting to speculate. We want to know what was going on in the driver's mind. What caused the driver to be at that location at that exact time? What caused the driver to exit the vehicle and walk to the back of it? What caused the driver to get back into the vehicle and pull forward? Our investigators do not have the power to answer questions that can only be answered by the SUV driver, but they conducted an exhaustive investigation examining physical evidence, interviewing every available witness, obtaining an exemplar vehicle, examining the quality of the interior railcar materials, conducting a train sight distance test, and much more. While we will never know what the driver was thinking that evening and, importantly, as an investigative agency, we refuse to speculate, after conducting our detailed analysis of the evidence, we do know much of what happened.

Before crossing the boundary onto the highway-railroad grade crossing, the SUV driver passed five different highway markings indicating that the driver was approaching a grade crossing. We do not know whether the driver knew or did not know that the vehicle was on railroad tracks before or at the time of the accident. But the real question we need to examine is why this accident happened, so we can make recommendations to ensure it does not happen again.

Our report accomplished just that in the findings and recommendations.

In the end, nothing about the design of the highway-railroad infrastructure caused the car to stop on the highway-railroad grade crossing. The highway-railroad grade crossing signage complied completely with federal and state standards. The NTSB made no recommendations to change anything in this regard. The highway preemption correctly detected and signaled for the train allowing any traffic queue which may have existed to clear the tracks. The timing and the operation of the preemption worked as designed and complied with federal and state standards. We made no recommendations with respect to preemption. The highway infrastructure operated as designed and was safely designed.

The train was in good mechanical condition and the engineer placed the train into emergency braking at a reasonable and prudent time under the circumstances. The weather was not causal. Neither the SUV driver nor the train engineer were fatigued, suffering from medical conditions that affected their performance, or were impaired by alcohol and other drugs.

After ruling out everything that ***did not*** cause the accident, quite simply, we concluded that the probable cause was the SUV driver, for undetermined reasons, moved the vehicle forward into the path of oncoming train. It resulted in tragedy for dozens of families. Our recommendations seek to prevent this from happening again.

In our recommendations, we ask both the regulator and the operators to examine grade crossings near third rail operations to conduct a risk assessment and implement any results to mitigate this type of catastrophic penetration of the third rail into railcars. We recommend the state of New York examine whether it should close certain grade crossings, including Commerce Street, to improve safety. We applaud the ongoing efforts of the Operation Lifesaver, the Federal Railroad Administration, the Metropolitan Transportation Authority, and the Metro-North Railroad to increase public awareness of the dangers of highway-railroad grade crossings. We also are very encouraged by the work of the Federal Railroad Administration with GPS providers to integrate highway-railroad grade crossing information into navigation applications available to drivers.

This exhaustive investigation and detailed report provides key recommendations that will aid in preventing this type of tragic accident in the future.

Acting Chairman Robert L. Sumwalt, III joined this statement.

**Member Earl F. Weener filed the following dissenting statement on August 1, 2017.**

I submit this statement to address concerns regarding the scope and probable cause determination of this report. The NTSB investigates accidents to help prevent future similar tragedies. We do not lay blame or assign fault. Any death resulting from a preventable transportation accident is unacceptable. In the collision between the SUV and train involved in this event, six lives were lost. It falls to the NTSB to ask why this occurred and how it could have been prevented.

We know many facts about this accident. A prior accident caused both a detour and slow-moving traffic. The detour route was partially snow covered, and it was dark. At some point, the SUV driver and a following driver became completely stopped by traffic. The SUV was stopped just beyond the stop line, then warning lights activated. The SUV remained stopped and a gate descended on the rear of the vehicle. This crossing was not equipped with warning bells. The driver exited the SUV, walked to its rear, touched the gate, and reentered the vehicle. The SUV was fouling the track, and would likely have caused a collision with a passing train. The SUV moved forward on to the tracks, directly into the path of the oncoming train, resulting in a multiple-fatality collision occurred. These events occurred within 40 seconds.

We can also conclude that the SUV had stopped initially in response to traffic ahead. At this point, there was at least one vehicle immediately behind the SUV. Several seconds before the collision, as the engineer saw the SUV moving forward, the traffic ahead of the SUV had cleared. After the crossing activated, the following driver reversed, attempting to increase the distance between the SUV and the following vehicle. The gate remained down, behind the SUV, the warning lights continued to flash red, and the traffic light across the tracks was green to clear traffic over the tracks.

The available evidence limits further conclusions. The following driver was unable to see the traffic in front of the SUV, and, despite some confusion during the meeting, there is no evidence regarding exactly how long the traffic in front of the SUV continued to block its forward path. We do not know what the SUV driver did or was able to perceive relating to the crossing markings or the train's approach. Given the collected data, our analysis, and the witness statements, the SUV driver's ability to hear or understand the warning whistle of the train is unclear. We do not know why the driver exited or returned to the SUV, or why the driver then moved the vehicle forward across the tracks. It is human nature to put oneself in the place of another, trying to interpret or judge whether actions are reasonable given all the circumstances. However, speculation does not serve those affected by this accident or further the investigation.

It is as important or, perhaps more important, to ask how the SUV ended up within the crossing gates as to consider how the driver attempted to exit the crossing. While the dangers of the third rail are clear, if the driver had stopped before the stop line, no accident would have occurred. Had the driver not pulled forward, the accident would almost certainly have been substantially less severe. I had hoped to see more emphasis placed on the causes of the SUV driver's actions. While the report notes warning markings along the approach to the track met minimum federal standards, it is reasonable to ask whether minimum standards are sufficient, particularly in conditions subject to winter weather, without supplementary lighting, or subject to volume delays.

The report seems instead to focus on the theories that the SUV driver became distracted by the gate striking the SUV and that the driver's exit from SUV and examination of the gate reduced the available time to clear the tracks. While possible, these theories seem speculative and suggest only one of many possible scenarios. It is possible that the SUV driver drove forward as soon as traffic ahead cleared. While the SUV driver may have been able to move backwards, it is unclear when and how far back the following driver moved to allow the SUV to reverse. We cannot be sure the SUV driver felt the gate's impact and correctly interpreted it as caused by the gate rather than another object, or a vehicle. Possibly, the driver exited the SUV to investigate the impact or, because of front and rear blind spots, to visually assess the SUV's proximity to the tracks.

I am persuaded by evidence, including a witness statement, that the driver likely lost situational awareness between the time the SUV passed the crossing signs and road marking and, perhaps several minutes later, stopped within the crossing. As the Acting Chairman suggested during the meeting, the SUV driver may not have realized the SUV's proximity to the tracks. After the driver left the SUV, the following driver's headlights could have made accurately assessing the SUV's position difficult, and we do not know what the SUV driver perceived. It is impossible to say if the driver could tell if the SUV had room to reverse safely or whether the gate would allow it.

I was glad to hear Operation Lifesaver discussed during this Board meeting. This Board has previously addressed the importance of educating rail crossing users. While it is impossible to say how an experienced driver with a relatively good driving history wound up on the wrong side of the stop line in this accident, rail crossing accidents are not uncommon. We did not examine the adequacy of driver education regarding the appropriate procedures for crossing tracks in slow moving traffic. Past rail safety efforts have worked on model legislation to deter drivers from advancing into crossings without first making sure the way completely across is clear. We did not examine the sufficiency of New York State's existing law or its enforcement, nor did we make any recommendations related to it or its potential deterrent or educational benefits.

My final observation relates to driver self-rescue, an issue not well covered in this report. No driver should proceed into a roadway intersection or rail crossing without being certain that the way across is clear. However, drivers are human and can, all too easily, find themselves inside a crossing that has become active. It is for this reason that many crossing gates are frangible, allowing trapped drivers to break through them. This feature, however, is only useful if drivers are made aware about what to do when caught by gates. I wonder if sufficient education is being given to drivers on this topic. This issue was not explored in the report.

I am concerned that comments during the meeting may suggest that the SUV driver should have waited, inside a stopped vehicle within an active crossing, for traffic to clear before moving forward, across the tracks. If a driver is moving at or near the posted speed and finds himself inside the crossing when the alarms activate, then, as with a green light that has turned yellow, the driver should keep going to clear the crossing allowing it to function as designed. If, however, a driver is prevented from immediately moving forward or backward due to traffic or vehicle immobility, the driver should leave the vehicle and move away. In this case, if the driver could not move the vehicle after the warning activated, exiting the vehicle to flee would have been correct. If only the way ahead was blocked, and it was possible to immediately reverse the SUV, this would have been correct. Once a crossing becomes active, drivers have only seconds to reach safety. Waiting inside a trapped vehicle for any reason or length of time is extremely dangerous. Moving a vehicle that has stopped further onto tracks under active warning does not seem consistent with known guidance.

I am left unsatisfied as to how the configuration of this angled crossing, the signage approaching the crossing, the deterrent effect of existing New York rail crossing statutes, and the New York State driver education regarding rail crossing safety may have affected these events. Further, I am concerned that the statement of probable cause does not reflect the real causes of this accident. It is my hope that the State of New York, federal authorities, local municipalities, state driver licensing agencies, and all safety stakeholders will consider these events and look for ways to prevent similar events in the future.

# 6. Appendix

## 6.1 Appendix A. Investigation

The National Transportation Safety Board (NTSB) was notified on February 3, 2015, of the collision of northbound Metro-North Railroad passenger train 659 with a 2011 Mercedes Benz ML350 sport-utility vehicle at the Commerce Street highway-railroad grade crossing on the Harlem Line. The NTSB launched Board Member Robert Sumwalt, who was the on-scene spokesperson, and a team to investigate highway human performance, the highway-railroad grade crossing, track and power, signals and train control, railroad operations, survival factors and crashworthiness, mechanical/equipment, event/data recorders, and an investigator-in-charge.

The NTSB Transportation Disaster Assistance division was also on scene to provide assistance with victims and victims' families.

The parties to the investigation include Metro-North Railroad; the Federal Railroad Administration; the Association of Commuter Rail Employees; the town of Mount Pleasant, New York; and the New York Public Transportation Safety Board.

## 6.2 Appendix B. Chronology of Events

The following is a chronological list of the events that occurred during this accident.

**Table A.** Chronological listing of accident events.

| Time[a] | Event |
|---|---|
| 6:25:34 p.m. | South approach track circuit indicates occupied (train 659 detected)<br>Grade crossing flashing light units activate |
| 6:25:38 p.m. | Grade crossing gate arms release and begin descending |
| 6:25:47 p.m. | Grade crossing gate arms in full horizontal position |
| 6:26:10 p.m. | Train 659 emergency brake applied |
| 6:26:13 p.m. | Island track circuit indicates occupied |
| 6:26:13 p.m. | Train 659 collides with SUV |
| 6:26:15 p.m. | North approach track circuit indicates occupied (train 659 across Commerce Street) |
| 6:26:21 p.m. | Protective relay trip at substation B26 |
| 6:26:51 p.m. | Protective relay trip at substation B29 |
| 6:27:20 p.m. | Power Director de-energizes substation B29 |
| 6:27:50 p.m. | Power Director de-energizes substation B26 |
| 6:28:08 p.m. | Westchester Department of Emergency Services Communications Center logged first call regarding the collision |
| 6:28:25 p.m. | Valhalla Volunteer Fire Department dispatched to collision |
| 6:34:24 p.m. | Valhalla Volunteer Fire Department arrives on scene |

a. Grade crossing data log clock time was synched to on-board event recorder clock time.

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