Organizational Factors in Metro-North Railroad Accidents

Special Investigation Report

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PB2015-101211

National Transportation Safety Board

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National Transportation Safety Board

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Abstract: During the time period between May 2013 and March 2014 the National Transportation Safety Board (NTSB) launched investigative teams to five significant accidents on the Metro-North Railroad (Metro-North): (1) the May 17, 2013, derailment and subsequent collision in Bridgeport, Connectivut; (2) the May 28, 2013, employee fatality in West Haven, Connecticut; (3) the July 18, 2013, CSX drailment on Metro-North tracks in The Bronx, New York; (4) the December 1, 2013, derailment in The Bronx, New York; and (5) the March 10, 2014, employee fatality in Manhattan, New York. In combination, these accidents resulted in 6 fatalities, 126 injuries, and more than $28 million in damages.

This special investigation report discusses all five of the recent Metro-North accidents investigated by the NTSB, examines some of the common elements of these accidents, and addresses the steps that Metro-North, the Metropolitan Transit Authority (MTA), and the Federal Railroad Administration have taken as a result of these investigations. This report also highlights lessons learned and provides recommendations to Metro-North, MTA, and several other entities to improve railroad safety on Metro-North and elsewhere.

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Abbreviations and Acronyms

AAR	Association of American Railroads
AHI	apnea/hypopnea index
APTA	American Public Transportation Association
ATC	automatic train control
BMWE	Brotherhood of Maintenance of Way Employes
BMI	Body Mass Index
BRP	Blue Ribbon Panel
BTS	Bureau of Transportation Statistics
C3RS	Confidential Close Call Reporting System
CFR	*Code of Federal Regulations*
CN	Canadian National Railway Company
Conrail	Consolidated Rail Corporation
CP	control point
CPAP	continuous positive airway pressure
CWR	continuous welded rail
DOT	US Department of Transportation
EO	Emergency Order
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GAO	Government Accountability Office
GRMS	gage restraint measurement systems
LIRR	Long Island Railroad
MP	milepost
MTA	Metropolitan Transportation Authority
NIP	National Inspection Plan
NJT	New Jersey Transit
NPRM	Notice of Proposed Rulemaking
NTSB	National Transportation Safety Board
OCC	operations control center
OIG	Department of Transportation Office of the Inspector General
OSA	obstructive sleep apnea
POD	point of derailment
PTC	positive train control
PTSB	New York State Public Transportation Safety Board
RSAC	Railroad Safety Advisory Committee
RSIA	Rail Safety Improvement Act of 2008
RTC	rail traffic controller
SMS	safety management system
SSPP	Metro-North System Safety Program Plan
TTCI	Transportation Technology Center, Inc.
Volpe	Volpe National Transportation Systems Center

1 Introduction

During the time period between May 2013 and March 2014, the National Transportation Safety Board (NTSB) launched investigative teams to five significant accidents on the Metro-North Railroad (Metro-North): (1) the May 17, 2013, derailment and subsequent collision in Bridgeport, Connecticut; (2) the May 28, 2013, employee fatality in West Haven, Connecticut; (3) the July 18, 2013, CSX derailment on Metro-North tracks in The Bronx, New York; (4) the December 1, 2013, derailment in The Bronx, New York; and (5) the March 10, 2014, employee fatality in Manhattan, New York. In combination, these accidents resulted in 6 fatalities, 126 injuries and more than $28 million in damages. The continued safe operation of Metro-North is vital to New York City and the tri-state area of New York, New Jersey, and Connecticut.

As the NTSB investigations progressed, it became apparent that several organizational factors issues were involved in the accidents. The November 2013 NTSB investigative hearing on the Bridgeport and West Haven accidents (the NTSB hearing) explored the role of Metro-North and the Federal Railroad Administration (FRA) organizational factors in these accidents. The NTSB was not alone in observing that organizational factors were relevant to the series of Metro-North accidents. Subsequent actions by the FRA, which conducted a focused audit, and the Metropolitan Transportation Authority (MTA), which formed a Blue Ribbon Panel (BRP) to review safety and created an MTA Board Safety Committee to monitor safety, have reinforced the need to examine both the role of Metro-North and FRA organizational factors in relation to these five accidents.

This special investigation report discusses all five of the recent Metro-North accidents investigated by the NTSB, examines some of the common elements of these accidents, and addresses the steps that Metro-North, the MTA, and the FRA have taken as a result of these investigations. The report also highlights lessons learned and provides recommendations to Metro-North, MTA, and several other entities to improve railroad safety on Metro-North and elsewhere.

2 Background Information

2.1 Metro-North Operations

Metro-North operates over three main routes east of the Hudson River, all originating at Grand Central Terminal in Manhattan. The Hudson Line extends north up 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.

Metro-North also maintains infrastructure on two lines in New York west of the Hudson River (the Port Jervis and Spring Valley lines). New Jersey Transit maintains the rolling stock and operates the train service on those lines (see figure 1).

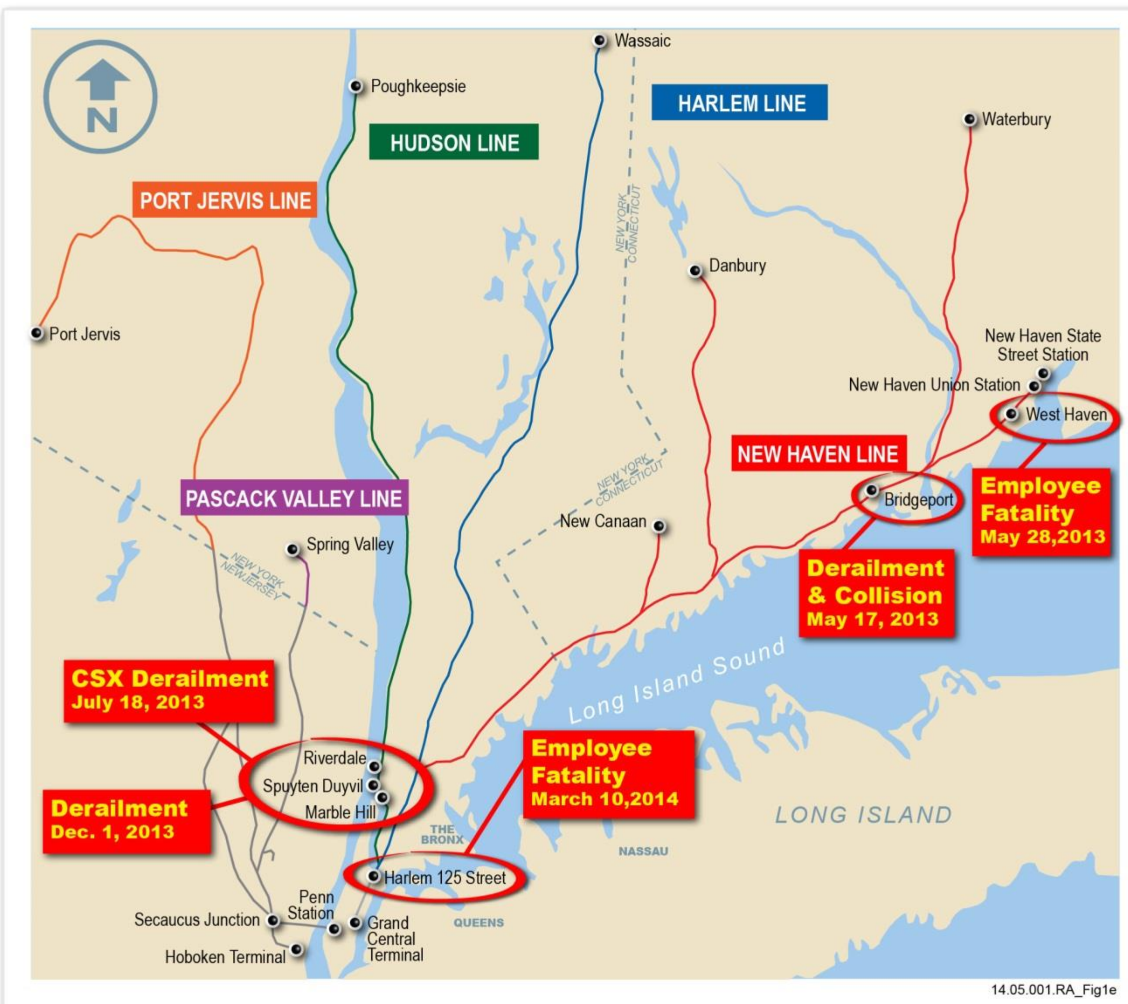

Figure 1. Metro-North route map and locations of the five accidents.

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 83 million passengers. In addition, Amtrak operates about 22 trains per weekday on Metro-North tracks. CSX Transportation, Norfolk Southern, Consolidated Rail Corporation (Conrail), and several railroad short lines also operate freight trains on Metro-North tracks.

Metro-North operates trains with a number of different types of passenger equipment. Some are electrically powered multiple-unit trains using third-rail or overhead catenary wires, and others are diesel-powered locomotives that push or pull passenger trains. Diesel electric locomotives operating into Grand Central Terminal transition to third-rail power in underground areas. Train operations on the Hudson, Harlem, and New Haven lines are overseen by rail traffic controllers (RTC) in the Metro-North Operations Control Center (OCC), which is located in Grand Central Terminal.

2.2 Metropolitan Transportation Authority Oversight

Metro-North operates as a subsidiary of the New York MTA. The New York City Transit (NYCT), which includes subways and buses, Long Island Railroad (LIRR), Metro-North, Staten Island Railroad, and certain tunnels and bridges also fall under MTA oversight. The Metro-North president reports to the MTA Board of Directors. The MTA Board is composed of 23 appointed members with one seat currently vacant. A Metro-North committee, comprising 13 MTA Board Members, meets monthly to oversee specific aspects of Metro-North operations. In 1995, the MTA Safety Committee was established, and a few years later, security matters were added to the committee’s oversight responsibilities. In March 2012, oversight over agency safety was reassigned to the individual MTA operating agency committees. In 2014, the MTA re-established a Board-level safety committee to oversee safety on Metro-North as well as on other MTA operating entities.

2.3 Federal Railroad Administration Oversight

Metro-North is regulated by the FRA. Main functions of the FRA include the promulgation and enforcement of federal safety regulations, administering railroad assistance programs, and conducting research and development in support of improved railroad safety and national rail transportation policy. The FRA regulates the operation of railroads that are part of the general railroad system of transportation, including freight, intercity passenger, and commuter railroads. The FRA does not regulate rail transit systems in urban areas that are not connected with the general railroad system, except under some very limited and clearly defined circumstances. Such transit systems are under the jurisdiction of the Federal Transit Administration (FTA).

The FRA is authorized to issue an emergency order in situations where the FRA believes an unsafe condition or practice exists that can result in a death or personal injury. The FRA was a party to all five NTSB investigations.

3 The Accidents

It is unusual for the NTSB to have five ongoing investigations involving a single railroad like Metro-North. The NTSB convened this special investigation to examine the similarities of the five accidents and to identify any safety-significant issues that otherwise might not have been observed in the individual investigations. This section discusses each of the five recent accidents on Metro-North.

3.1 Derailment and Subsequent Collision of Two Metro-North Passenger Trains in Bridgeport, Connecticut, May 17, 2013

At 6:01 p.m. eastern daylight time on Friday, May 17, 2013, eastbound Metro-North passenger train 1548 derailed at milepost (MP) 53.25 on main track 4 of the New Haven Line and was subsequently struck by westbound Metro-North passenger train 1581 operating on main track 2 (see figure 2).[1] At least 65 persons were injured. Metro-North estimated about 250 passengers were on each train at the time of the accident.

[1] All of the accidents occurred during eastern daylight time except for the December 1, 2013, derailment in The Bronx, which occurred during eastern standard time.

Figure 2. Excerpt from Metro-North system map showing Bridgeport, Connecticut, accident location.

Both Metro-North trains consisted of eight electrically powered, multiple-unit passenger railcars. The lead car of the striking train and the fourth car of the struck train were severely damaged. The derailed trains destroyed 714 feet of main track 4, the catenary wires above, and 220 feet of main track 2. Property damage was estimated at $18.5 million.

Figure 3. Metro-North passenger trains 1548 (right) and 1581 (left) looking east.

Metro-North train 1548 originated in Grand Central Terminal with a final destination of New Haven, Connecticut. At the Fairfield Metro Station, the train was operating on main track 4 and made a normal station stop. According to train crew interviews and event recorder data, the train approached MP 53.3 at 74 mph. The locomotive engineer said at about that point he thought he saw a track defect in the left rail as the train approached the curve under the Interstate 95 bridge. The lead truck of the first car passed over the track defect, however, the second truck derailed. The remaining cars in the train also derailed, but all cars remained upright.

The westbound train originated at New Haven, Connecticut, with a final destination of Grand Central Terminal. It left the Bridgeport station and accelerated to 74 mph. As the train approached the derailed eastbound train, the engineer said he saw an electric arc and what he thought were overhead catenary wires falling down, so he immediately initiated an emergency brake application. About 16 seconds later, the train, which had slowed to 23 mph, struck the third and fourth cars of the derailed train.

About 48 minutes before the accident, an Amtrak train passed MP 53.25 heading west on main track 2. A still image from the forward-facing video camera on the Amtrak train shows a segment of rail missing on the north rail of main track (see figure 4). Over the next 48 minutes, four Metro-North passenger trains successfully traveled across the damaged rail. The crews on these trains did not report any track abnormalities.

Figure 4. Amtrak train video still shows the missing rail segment before the accident.

3.1.1 Track Maintenance and Inspection

Main track 4 in the derailment area was primarily continuous welded rail (CWR) on wooden crossties and supported by crushed rock ballast. About 49 Metro-North trains and 23 Amtrak trains operate along the route daily, in addition to limited freight service. The estimated total annual tonnage over each track is 5 million gross tons. The track in the area of the derailment was designated as Class 4 track under FRA regulations.[2] The maximum allowable operating speed for passenger trains was 80 mph.

Two 36-inch compromise joint bars were found broken at the point of derailment (POD) (see figures 5 and 6). Joint bars are bolted to the outside (field side) and the inside (gage side) of the two rails being joined. Compromise joint bars join two rails that are of different weight and cross sectional dimension. These compromise joint bars joined 136-pound (per yard) rail with 131-pound (per yard) rail.

[2] Title 49 *Code of Federal Regulations* (CFR) 213.9, established maximum authorized track speed for Class 4 track as 60 mph for freight trains and 80 mph for passenger trains.

Figure 5. Broken compromise joint bars on the 131-pound rail end of main track 4.

Figure 6. Photograph of the east 136-pound rail end and broken compromise joint bars with impact/batter/breaks on the rail end.

According to the Metro-North assistant vice president–chief engineer, the Metro-North procedure for installing compromise joint bars at the time of the installation stated that if a rail end mismatch exists, weld metal should be added to the lower rail to meet the higher rail (referred to as weld “build up”). However, the track maintenance workers did not use this welding technique on this joint fit-up. Instead, when the rail joint was assembled, the workers ground the top of the higher 136-pound rail along a length of about 12 inches to smooth the transition between the 131-pound rail and the 136-pound rail. They also ground the rail gage face on the 131-pound rail to improve the compromise joint bar fit on the two rails.

A smooth transition at rail joints is needed to limit the impact forces from train wheels passing over the joint. The POD area showed wheel marks beginning at the broken compromise joint bars and extending to the resting position of the derailed cars. The end of the 136-pound rail showed impact batter and two portions of the rail head were broken off. Both joint bars had evidence of fatigue cracking. The fracture faces on both joint bars showed significant contact damage as a result of movement between the mating fracture faces as trains passed over the joint.

The Metro-North assistant vice president–chief engineer stated during the NTSB hearing that the maintenance crew did not use the welding procedure to align the rails at the broken compromise joint because the Metro-North standards were out of date and Metro-North lacked skilled welders. He said that many of the welders with the skill level to perform the recommended welding technique had retired. He elaborated:

> Apparently. the installers of this joint ground down the joint in such a way that allowed this mismatch to happen. They didn’t taper off the joint in the proper way or grind down the joint in a proper way to avoid the impact load that was created because of it.

He also stated that the procedure was out of date because the current Metro-North practice was to eliminate as many bolted rail joints as possible by welding the two rail ends creating CWR. He explained that build-up welding to improve the fit impedes the future transition from bolted rail joints to CWR because rail ends that have been built up by welding cannot be welded again without extensive grinding. After the accident, Metro-North developed an accelerated program to replace all compromise joints with a welded rail.

The Metro-North cyclic maintenance program for rail surfacing was on a 3-year schedule and tie replacement was on a 6- to 7-year schedule.[3] Contrary to the program plan, the Metro-North assistant vice president–chief engineer stated at the NTSB hearing that Metro-North was “behind in…tie cycles and surfacing.”

In addition, he said a long-term track outage project was being conducted on main tracks 1 and 3, which required rerouting all rail traffic to main tracks 2 and 4. However, they did not perform any additional programmed maintenance, such as surfacing the track, on main tracks 2 and 4, where the accident occurred, in preparation for the additional train traffic.

During an interview with NTSB investigators, the Metro-North assistant director of track maintenance further explained the difficulty in conducting the track maintenance as planned:

> Ideally, we want to run a 3-year cycle with surfacing. And it’s—we can’t get the track time to do it. We're actually running short on operators now because we’re getting a lot of retirements. And it gets harder every year to keep that cycle up. I mean, and then they don’t like to give the outside tracks out [make them available for maintenance] because of on-time performance. I mean, we get them, but it’s very limited amounts of time.

3.1.2 Track Inspections

FRA regulations require Metro-North to perform two walking inspections of the CWR joints a year.[4] The last inspection was conducted 7 weeks before the derailment. At that time, both compromise joint bars were observed to be broken and pumping under load at MP 53.25 (the subsequent POD). Pumping under load refers to the vertical movement of the

[3] *Surfacing* is the process of realigning the tracks back to the designed profile and geometry. Over time, tracks develop deviations from alignment, curvature and superelevation. Surfacing restores the tracks to their original alignment.

[4] Title 49 CFR 213.119(6)(i).

track as train car wheels pass over. The inspection report noted that the bars were replaced and the ballast was hand tamped in the joint area. These were localized repairs to address an immediate condition.

FRA regulations also require two visual track inspections (either by walking or by hi-rail) per week with at least 1 calendar day between inspections.[5] Metro-North last conducted the visual inspection from a hi-rail vehicle on May 15, 2 days before the derailment.[6] The records indicated the inspection was most likely performed from main track 2. The NTSB notes that the gage side of the rail on main track 4, including the gage side of the compromise joint bar, which had the largest fatigue crack and was the first to break, would not have been visible from a hi-rail vehicle traveling on main track 2. However, the inspection report did note a joint with “hanging ties” and “pumping under load” at what would be the POD. Hanging ties refers to ties that are not fully supported by the ballast. The report contained no measurements on the amount of vertical “pumping” movement.

At the NTSB hearing, the Metro-North assistant vice president–chief engineer was asked if measurements were required when pumping was noted. He responded that the lack of any measurements was a surprise to him:

> A: They should be measuring and identifying exactly what the condition is, so I cannot explain why they have not done that.
>
> Q: So it’s a surprise to you that you're not seeing measurement values on the back side of the form?
>
> A: Yes, it is, sir.

The NTSB determined that the probable cause of the derailment was an undetected broken pair of compromise joint bars on the north rail of track 4 on the Metro-North Railroad New Haven subdivision at milepost 53.25 resulting from: (1) the lack of a comprehensive track maintenance program that prioritized the inspection findings to schedule proper corrective maintenance; (2) the regulatory exemption for high-density commuter railroads from the requirement to traverse the tracks they inspect; and (3) Metro-North’s decisions to defer scheduled track maintenance.[7]

3.1.3 NTSB Recommendations on the Adequacy of Inspections in Multiple Track Territory

As noted above, FRA regulations require an inspection frequency for Class 4 track of twice weekly with at least 1 calendar day interval between inspections. In addition, 49 CFR 213.233 states, in part, the following:

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[5] A *hi-rail vehicle inspection vehicle* is typically a pickup truck with retractable rail wheels that allow on track movements; 49 CFR 213.233(4)(c).

[6] Metro-North internal standards called for three inspections per week, but only two were conducted during the week before the derailment.

[7] The complete brief of this accident is attached to this report as Appendix A.

> (b) (2) Two inspectors in one vehicle may inspect up to four tracks at a time provided that the inspector's visibility remains unobstructed by any cause and that each track being inspected is centered within 39 feet from the track upon which the inspectors are riding;
>
> (b) (3) Each main track is actually traversed by the vehicle or inspected on foot at least once every two weeks, and each siding is actually traversed by the vehicle or inspected on foot at least once every month. On high density commuter railroad lines where track time does not permit an on track vehicle inspection, and where track centers are 15 foot or less, the requirements of this paragraph (b) (3) will not apply.

According to Metro-North maintenance personnel, the vast majority of track inspections were conducted from one of the two inside tracks (main tracks 1 and 2) and during those inspections all four tracks would be simultaneously inspected by the two track inspectors riding together in the hi-rail vehicle (see figure 7). Metro-North took advantage of the FRA high-density commuter rail exemption in 49 CFR 213.233(b)(3), above, which allows two track inspectors to inspect up to four main tracks while riding on a single track in a hi-rail vehicle. This inspection technique resulted in a minimal disruption to train operations.

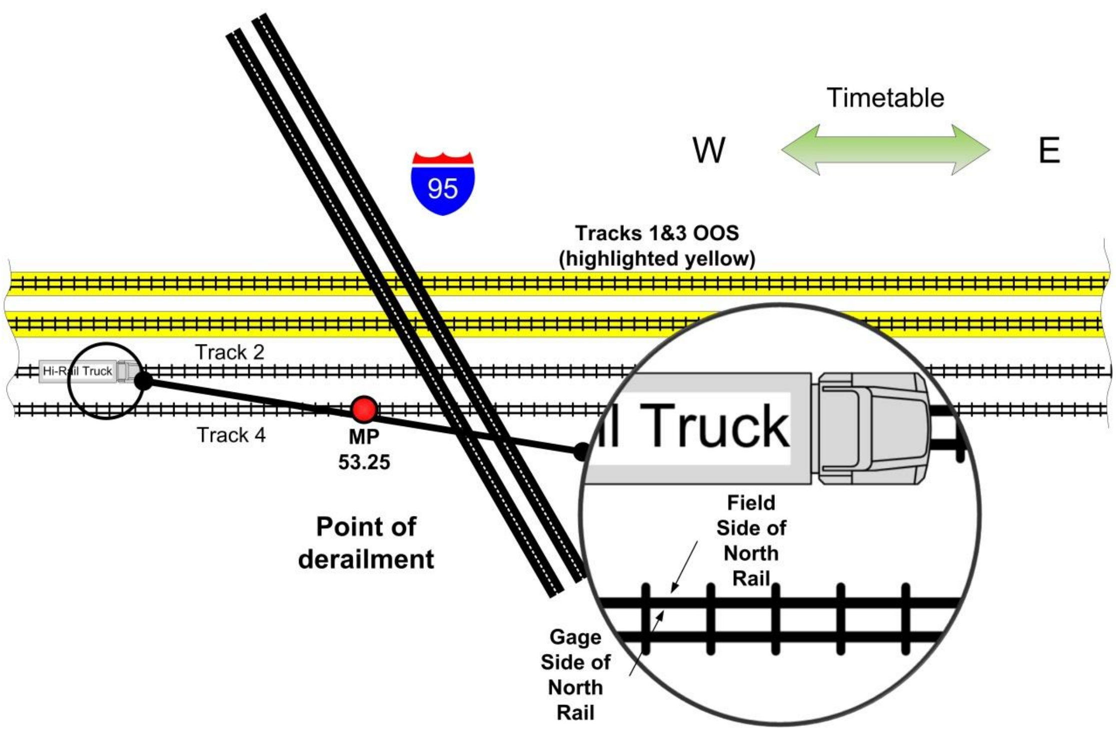

Figure 7. Diagram of Bridgeport derailment area and route of track inspection vehicle.

Metro-North track inspectors told investigators that when they did get an opportunity to inspect the outside tracks (main tracks 3 and 4) while riding over them in their hi-rail inspection vehicle, they had to rush. This was verified by the assistant track supervisor who said the inspectors brought this issue to his attention. Another manager said that train density was increasing so much that it was difficult to schedule track maintenance. He said on-time train schedule performance took precedence.

At the NTSB hearing, the Metro-North assistant vice president of maintenance of way-chief engineer was asked when the last walking or hi-rail inspection was conducted on main track 4 in the area of the derailment such that main track 4 was physically traversed (as opposed to an inspection from an adjacent track). He stated that, based on his review of records from January 2013 through May 17, 2013, he was unable to determine the last time main track 4 was physically walked or traversed by a hi-rail inspection vehicle. Nonetheless, he explained that in his opinion, Metro-North track inspectors had sufficient time to perform adequate inspections. Commenting on a Brotherhood of Maintenance of Way Employes (BMWE) survey, he said:

> I was able to compare all the attributes that they surveyed, and I can see that Metro-North typically had more time to inspect, had more inspectors per mile of track, had a lot more liberties than the industry norm seems to be. So my perception is, and still is today, that there is sufficient time for them to inspect the track properly.

However, the director of safety for the BMWE, who also testified at the NTSB hearing, explained some of the limitations of inspecting multiple adjacent tracks from a single track:

> If you're always riding on, say, a middle track, it's very difficult, if not impossible, for an inspector to see what is on the blind side of the tracks to their left or to their right.…you don't have that same perspective when you're dealing with multiple track inspection from a single point or a single track.

The NTSB previously expressed its concern about the adequacy of simultaneous inspection of multiple tracks and the importance of physically riding over the inspected track. In its December 18, 2012, comments on the FRA Notice of Proposed Rulemaking (NPRM) titled "Track Safety Standards: Improving Rail Integrity," the NTSB explained the basis for this concern as follows (*Federal Register* 2014, 64249):

> When inspecting track from a typical hi-rail vehicle, an inspector can see the track structure in front from about 20 feet. In addition to operating the vehicle and looking in the direction of travel for track defects 20 feet in front, an inspector may be expected to inspect an adjacent track up to 30 feet to the side. Furthermore, part of the inspection may include the sound or feel of the track as the inspection vehicle rides over the track. These parts of the inspection are not performed if the inspector is inspecting [from] adjacent track.…The NTSB believes that both gradual deterioration and rapid failures can create serious hazards, and the probability of detecting these hazards is substantially reduced when multiple tracks are being inspected simultaneously.

The NTSB remains concerned about the practice of inspecting adjacent track without physically traversing it on a periodic basis. This concern is especially relevant to high-density commuter railroads such as Metro-North. Accordingly, on May 19, 2014, the NTSB made the following recommendation to the FRA:

R-14-11

> Revise the Track Safety Standards specified in Title 49 *Code of Federal Regulations* 213.233(b)(3), removing the exemption for high-density commuter railroads and requiring all railroads to comply with these requirements: (1) to traverse each main track by vehicle or inspect each main track on foot at least once every 2 weeks, and (2) to traverse and inspect each siding, either by vehicle or on foot, at least once every month.
>
> Safety Recommendation R-14-11 is classified *Open—Await Response*.
>
> On May 19, 2014, the NTSB made a similar recommendation to Metro-North:

R-14-12

> Revise your track inspection program to include requirements (1) to traverse each main track by vehicle or inspect each main track on foot at least once every 2 weeks, and (2) to traverse and inspect each siding, either by vehicle or on foot, at least once every month.

In a reply dated October 17, 2014, Metro North stated that it had implemented a change to its track inspection program requiring every section of track to be physically walked or traversed by hi-rail at least once every 2 weeks. The revised procedure containing this new requirement also contains a provision stating that if the new requirement cannot be met because of operational requirements, other track outages, or for any other reason, track workers must notify their supervisor or the assistant director of maintenance. Pending further clarification from Metro-North on how missed inspections will be managed, Safety Recommendation R-14-12 is classified *Open—Acceptable Action*.

3.2 Metro-North Employee Fatality at West Haven, Connecticut, May 28, 2013

On May 28, 2013, at 11:57 a.m., Metro-North passenger train 1559, traveling westbound on the New Haven Line main track 1 at 70 mph, struck and fatally injured a track foreman in West Haven, Connecticut, about 100 feet west of catenary bridge 1021 (see figure 8).

14.05.001.RA_Fig2e

Figure 8. Map showing West Haven, Connecticut, accident location.

The track foreman reported for work at 8:00 a.m. on the day of the accident. He was given a job briefing by a supervisor, and he then, in turn, conducted a job briefing with the crew he would be working with that day. The work plan involved relocating segments of rail from main track 1 to industrial track 5 in the vicinity of the newly constructed West Haven Station using a locomotive crane (see figure 9). This work was in preparation for future raising and surfacing of track 1.

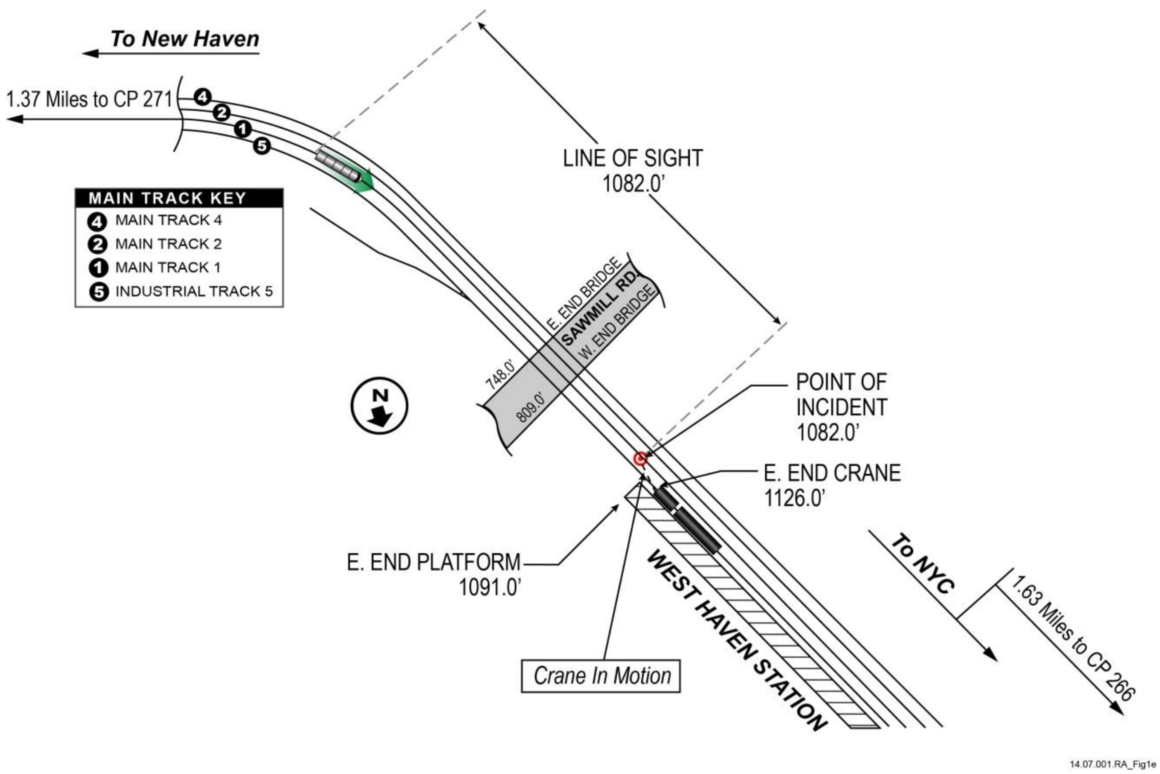

Figure 9. Accident area track diagram.

At 10:41 a.m., the track foreman contacted a Metro-North RTC at the OCC to request that main track 1 be removed from service between control point (CP) 266 and CP 271.[8] To fulfill this request, the RTC placed blocking devices to prevent trains from entering the area.[9] The RTC then issued authority at 10:42 a.m. to the foreman, taking main track 1 out of service until 4:00 p.m. This gave the foreman an exclusive work area on main track 1 between CP 266 and CP 271 until 4:00 p.m. According to Metro-North procedure, it could not be returned to service until the foreman released the authority back to the RTC.

About 10:45 a.m., the track supervisor informed the track foreman that no one was available to remove overhead power. Without overhead power removed, the height to which the crane boom could be raised safely was limited. The overhead catenary wires are typically about 17 feet above the track.

At 10:55 a.m., the track foreman contacted the RTC to request permission to move the locomotive crane from CP 257 to CP 266. The RTC issued a separate authorization at 10:56 a.m., giving the foreman authorization to travel on main track 2 from CP 257 to CP 266. This move was completed at 11:26 a.m.

[8] *Control points* are locations where RTCs can set up routes for trains to change tracks.

[9] *Blocking devices* are electronic locks applied in the OCC to prevent routing of trains onto tracks protected by the blocks. Applying and removing a blocking device involves clicking on a drop-down menu on a computer screen. When a blocking device is applied, an indication shows on the RTC's screen at the location where it is applied.

The foreman then requested verbal authorization from the RTC to proceed within the interlocking to move the crane from main track 2 west to main track 1 and then east into his exclusive work area. This authority was granted and the foreman moved the crane. The crane was positioned on industrial track 5 at about 11:45 a.m., and the foreman reported clear of main tracks 1 and 2.

Once on industrial track 5, the foreman reported to the RTC that he was in the clear of the interlocking on track 5 and proceeded west with the crane to the work site at the West Haven Station platform. At this location, the foreman and the crane operator decided to work from industrial track 5 and to operate the crane with a low boom.[10] By operating with a low boom, they would not need to remove power from the overhead catenary wires on the main tracks. They then checked the clearance between the crane counterweight and the platform area. Once they were satisfied that the crane could swing unimpeded without contacting the station platform, they began moving rail from main track 1 to industrial track 5. This process involved the foreman manually attaching rail tongs to the rail on track 1 and then using the crane to pick up and swing the rail toward industrial track 5 (see figure 10).

Figure 10. View of the work location on track 5, looking west.

[10] Metro-North rules required a 10 ft. separation between the boom and the energized line.

As the crane operator began moving rail from main track 1 to industrial track 5, the crane operator heard the horn of a train approaching from the east. Both the crane operator and track foreman continued facing east and had a view of the approaching train. The crane operator told investigators that he could not tell which track the approaching train was on due to a curve in the tracks. He said that he returned his attention to the work knowing that main track 1 was out of service. As the train neared, he said that he realized it was on main track 1 and tried to warn the foreman by yelling for him to run. He swung the boom clear of main track 1 just before the train arrived, thus minimizing the hazard to the train and its passengers. The track foreman was unable to clear the track. The train struck and killed the foreman and then struck the rail.

Event recorder data indicated that the striking train was operating at 70 mph, within its authorized speed of 75 mph. The engineer stated that he was sounding the horn in anticipation of workers being at the West Haven Station construction area. He stated that as he came around the curve he first saw the boom of the crane fouling main track 1, and then he observed the white hard hat of a worker standing between the rails of main track 1. The engineer continuously sounded the horn and made an emergency brake application before striking the foreman and rail. Sight distance measurement revealed that there was about 1,082 feet of preview. The stopping distance for the train was measured at 2,423 feet.

3.2.1 Rail Traffic Controller Procedures

Two RTCs at the OCC were covering the work location. One was a student RTC who had been hired in November 2012 and was working under the mentorship of a fully qualified RTC. The student RTC was receiving on-the-job training at the desk and was the one who applied the electronic blocking devices to protect the track for this work crew and issued the track authority to the foreman.

The student RTC said that when he heard the foreman state that he was in the clear on industrial track 5 at about 11:45 a.m. (that is, the crane was on industrial track 5 and clear of main track 1), he took that to mean that it was OK to remove the blocking device from main track 1. At 11:47 a.m., the student RTC removed the blocking device on main track 1 without first following the procedures for canceling the authority that had been issued to the track foreman. The qualified RTC who was responsible for supervising the student said that he did not see the student RTC remove the blocking device. He said he may have momentarily stepped away from the desk at that time.

Metro-North rules require a job briefing be conducted any time work conditions change. The unqualified student RTC being left alone staffing the desk constituted a change in work conditions. Investigators found no evidence that a job briefing occurred before the qualified RTC stepped away from the console, leaving the unqualified student RTC alone to manage train operations.

After the blocking device was removed at about 11:51 a.m., the student RTC aligned a route for train 1559 to proceed into the area where the track workers were moving the rail.

Prior to this accident, on May 4, 2013, a similar error occurred when an RTC inappropriately removed the blocking devices from an occupied track. This earlier incident did not result in damage or injury. This error was discovered when the track crew reported an unauthorized train incursion into their work area. No one was injured in that incident. In response, on May 6, 2013, Metro-North instituted additional operation control procedures, including a software enhancement that required RTCs to validate their intent to release track authorizations before removing the blocking devices. The student RTC did so before removing the blocking device on main track 1.[11] However, he did not follow other procedures that required confirming the removal with the track foreman.

The National Transportation Safety Board determined that the probable cause of this accident was the student rail traffic controller's removal (while working without direct supervision) of signal blocking protection for the track segment occupied by the track foreman and the failure of Metro-North to use any redundant feature to prevent this single point failure. Contributing to the accident was the Federal Railroad Administration's failure to require redundant signal protection, as recommended by Safety Recommendation R-08-6.[12]

3.2.2 NTSB Recommendations on Redundant Signal Protection

As a result of the West Haven accident, the NTSB advised Metro-North in a letter dated June 17, 2013, that the NTSB had investigated similar accidents and continues to believe that a redundant means of protecting railroad roadway workers (also called maintenance-of-way workers) from train movements is critically needed. The NTSB letter stated that the protective measures instituted by Metro-North on May 6, 2013, have been inadequate and made the following urgent safety recommendation to Metro-North:

<u>R-13-17</u> (Urgent)

> Immediately implement redundant signal protection, such as shunting, for maintenance-of-way work crews who depend on the train dispatcher to provide signal protection.

On July 17, 2013, Metro-North responded that it was "developing a technological process modification that puts the key to allowing the removal of a remote track blocking device in the hands of the roadway worker." The letter further stated that Metro-North was examining "the potential use of shunting devices where it may be viable on the Metro-North system," but noted that there was "an inherent danger that power from the third-rail would inadvertently be routed through the shunting device, creating a different danger to the roadway worker." Therefore, Metro-North was planning a pilot program to evaluate the use of shunts on track that did not have a third rail. Based on this response, on October 23, 2013, the NTSB classified Safety Recommendation R-13-17 *Open—Acceptable Response*.

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[11] The validation entailed a pop-up box on the computer screen with an icon that needed to be clicked on to confirm the intent of the RTC to remove the block.

[12] The complete brief of the accident is attached to this report as Appendix B.

In a letter dated April 11, 2014, Metro-North further responded that it had fully implemented "an automated system that allows an employee in the field to control the application of the blocking device by use of a computer-generated, random code known only to that employee."[13] The system, known as the enhanced employee protection system (EEPS), requires that the roadway worker-in-charge give a unique release code to the RTC to remove the blocking devices. Before the RTC can release a blocking device, the employee in the field must provide the unique code and the RTC must type it into the system. The letter stated that EEPS is designed to provide "redundancy and control by the roadway worker, rather than OCC personnel." On June 27, 2014, the NTSB classified Safety Recommendation R-13-17 *Closed—Acceptable Action*.

As a result of the West Haven accident, on June 17, 2013, the NTSB also reiterated Safety Recommendation R-08-6 to the FRA. That recommendation, which was issued as a result of the 2007 Massachusetts Bay Transportation Authority accident that killed two track workers at Woburn, Massachusetts, asked the FRA to:

<u>R-08-6</u> (Reiteration)

> Require redundant signal protection, such as shunting, for maintenance-of-way work crews who depend on the train dispatcher to provide signal protection. (NTSB 2008)

In response to R-08-6, the FRA stated that it would include the issue of alternate means of redundant protection in its upcoming NPRM on roadway worker protection and seek industry comment. As a result, on January 27, 2010, R-08-6 was classified *Open—Acceptable Response*. This recommendation is further discussed and reclassified *Open—Unacceptable Response* in section 4.4.2 of this report.

3.3 Derailment of CSX Train in The Bronx, New York, July 18, 2013

On July 18, 2013, at 8:29 p.m., northbound CSX train Q70419 derailed at MP 9.99 on main track 2 of the Metro-North Hudson Line (see figure 11). The train consisted of 2 locomotives and 24 modified flat cars each carrying 4 containers containing municipal refuse. The 11th through 20th cars derailed about 72 feet north of CP 10. The engineer of northbound Metro-North train 781, which was stopped at Marble Hill station on track 1 (MP 9.8), observed the passing CSX train and reported seeing sparks and dust flying when the CSX train derailed after passing his train. There were no injuries. Damage was estimated by CSX and Metro-North at $827,700. The weather at the time of the accident was reported as 91°F and clear.

[13] This system is in addition to, and separate from, the software enhancement developed after the May 4, 2013, event.

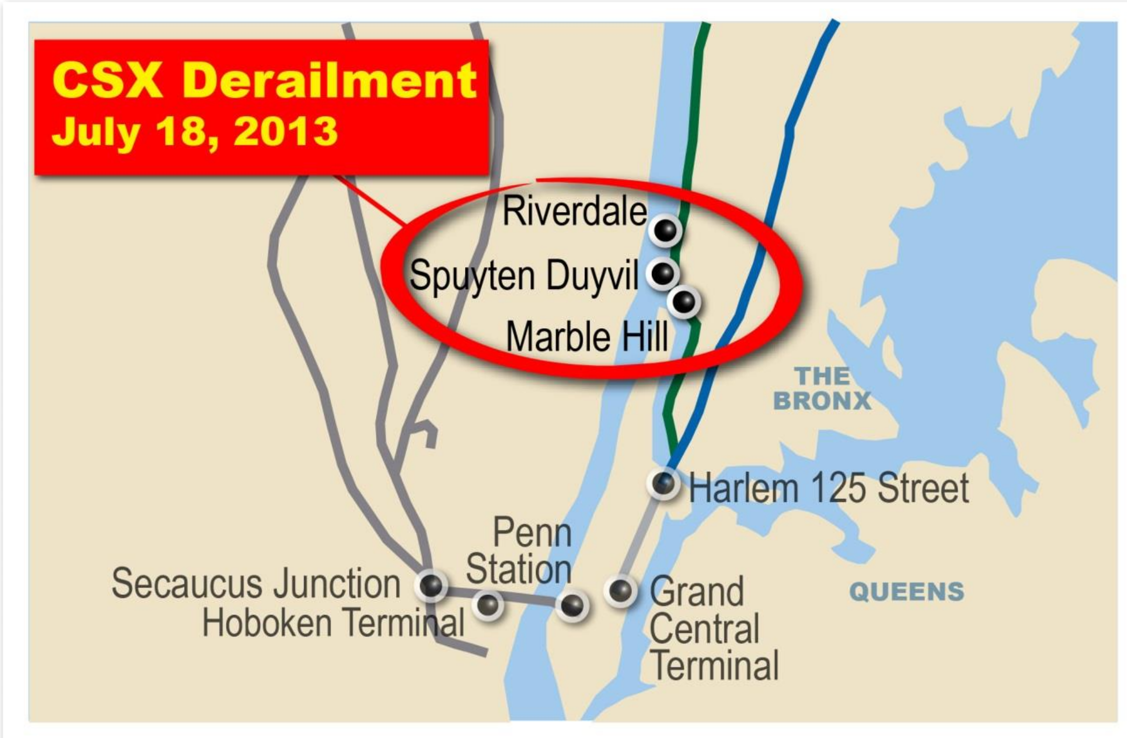

Figure 11. Excerpt from Metro-North system map showing location of the July 18, 2013, accident.

After being routed onto the Metro-North track, the CSX engineer said he increased the throttle in steps to full throttle, and when the maximum authorized speed of 15 mph was achieved. he reduced the throttle in steps to idle. He told investigators that this was his usual technique: to get up to speed and then “drift” through the curve, then to gradually increase throttle as the train was slowed by the curves. As the train slowed and the engineer began increasing the throttle, he received a radio call from Metro-North train 781 informing him that his train (CSX train) had derailed (see figure 12). The engineer said he immediately applied the full service air brake and shortly thereafter, the train went into emergency braking.

Both CSX locomotives were equipped with forward-facing video recorders.[14] The video from the leading locomotive had insufficient detail for close track examination. The video from both the front and rear locomotives showed movement consistent with a slight dip (that is, a low spot in the track) to the west in the general vicinity of the POD. The video from the rear locomotive did not show any other unusual movements of the first car in the train.

[14] The second locomotive was traveling backward so the video was facing the first car in the train.

Figure 12. Point of derailment area (right).

About 100 Metro-North trains and 4 to 6 CSX freight trains operate over the accident area on a daily basis. The estimated total annual tonnage over each track is about 20 million gross tons.

Figure 13. View of point of derailment area (Yellow reference line shows slight outward bow in the rail).

The configuration of the tracks in the area of the POD changed from four main tracks at Marble Hill Station to two main tracks at the derailment location. The tracks run parallel to the Harlem River with a negligible grade. Track in this area was designated by Metro-North as Class 2 track.[15] Maximum authorized train speeds were 30 mph for passenger trains and 15 mph for freight trains at the POD.

The track at the POD is CWR fastened on concrete crossties with Pandrol low shoulder clips and supported by crushed trap rock ballast (see figure 14).[16] The CWR through the curve was a mixture of 140- and 136-pound rail. Metro-North records show that the concrete ties were installed in 2000, rail was installed in 1993, and track was last surfaced in 2004. As noted previously, the Metro-North maintenance schedule called for resurfacing every 3 years and tie replacement every 6-7 years.

[15] FRA classifies track by number to indicate allowable train speeds and maintenance standards. Class 2 track allows passenger train speeds of 30 mph and freight train speeds of 25 mph. Metro-North further reduced allowable freight train speed to 15 mph.

[16] Pandrol is a brand of track fasteners used on many railroads.

Figure 14. Properly installed insulator between Pandrol clip and rail base. Note the insulator is positioned so there is no gap above the rail base.

In the vicinity of the POD, investigators observed the clip insulators on the field side of the rail had slipped out of place such that they were incorrectly positioned above the base of the rail on a number of ties (see figure 15). With the bottom of the insulator above the rail base, a gap was created allowing the rail to move outward thereby widening the gage by about 5/16 inch.

Figure 15. Insulator at the POD between the Pandrol clip and rail base, which has slipped above the base of rail, creating a gap.

Investigators observed soil intrusion into the ballast (referred to as fouled ballast) in the derailment area. Fouled ballast occurs when inadequate drainage results in a buildup of water in the track substructure. Hydraulic action, called “pumping,” as the train moves over the area causes fine soil particles to rise toward the surface, contaminating the ballast. Investigators also observed a gray powdery substance throughout the track structure in the POD area that was later determined to be from concrete tie abrasion. Movement of the ties in the ballast can abrade the ties, and the gray powdery substance indicates long-term tie movement and abrasion. Over time, pumping and fouled ballast conditions worsen and weaken structural support to the ties and track. Metro-North referred to areas like this as mud spots, and they were common on the system. Fouled ballast is symptomatic of a drainage problem but does not necessarily indicate a problem that train engineers would report. Such areas should be noted during track inspections and monitored. This was not always done on Metro-North. Because many fouled ballast locations had developed and continued to exist for such a long time, they may have been regarded as “normal” to track inspectors. The fouled ballast at the POD was not noted on the last track inspection before the derailment.

Google Earth satellite images from June 2010 (3 years before the derailment) showed that fouled ballast at the POD was not a recent phenomenon (see figure 16). A similar image about a year later shows the POD fouled ballast more clearly (see figure 17). The white material in the images is a combination of ballast and concrete dust mixed with soil (see figure 18).[17]

Figure 16. Satellite image from 2010 showing fouled ballast at the POD.

[17] Google Earth version 7.1, 2013. Imagery centered on 40.875832°, 73.916040°, dates June 17, 2010, and June 2, 2011. (viewed October 30, 2014).

Figure 17. Satellite image from 2011 showing fouled ballast at the POD.

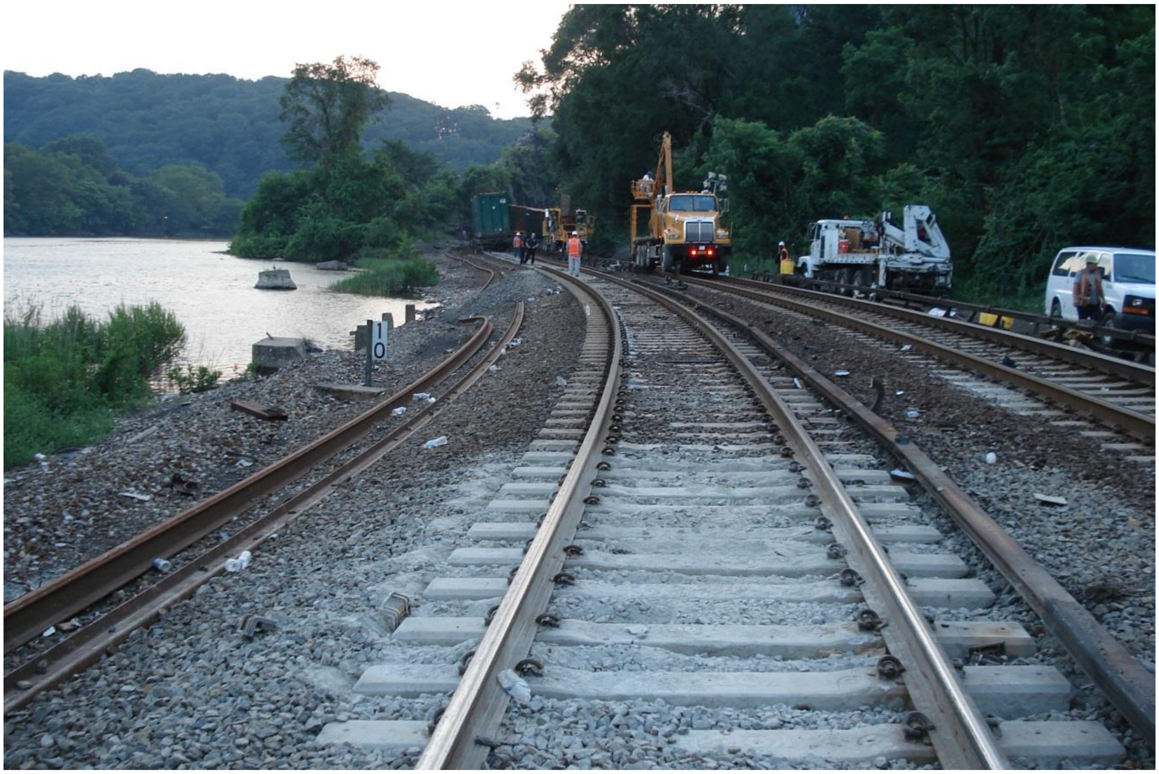

Figure 18. Close-up view of fouled ballast in POD area.

Following the May 17, 2013, Bridgeport derailment, Metro-North hired the Transportation Technology Center, Inc. (TTCI) to evaluate the Metro-North track maintenance program. As part of its evaluation, TTCI conducted a survey that identified 676 locations on the Metro-North system with poor drainage, including the accident location. TTCI provided a set of recommendations for improving Metro-North track inspection and maintenance. Metro-North provided the NTSB with an action plan on these recommendations that included better quality control of track inspections, using gage restraint measurement systems, increased use of track geometry vehicles, and moving to automated record keeping for track inspection data.

The FRA used a track geometry car to inspect the area of the derailment on June 4, 2013, about 6 weeks before the accident. The inspection report disclosed no exceptions to FRA track geometry regulatory standards for Class 2 track. However, a review of the inspection data from the June 4 inspection showed substantial track geometry deviations measured at the POD including a profile measurement of -2 inches (that is, a dip) in both rails and a gage of 57.81 inches.[18] In Class 2 track, the maximum allowable deviation in profile is 2 3/4 inches, and the maximum allowable gage is 57 3/4 inches. (Standard gage is 56 1/2 inches.) The profile measurement was within the deviation limits established by FRA regulations. Although the gage measurement exceeded the gage maximum limit, the geometry car does not flag a potential gage defect for verification unless the gage measurement exceeds the regulatory limit by at

[18] Inspection data from the geometry car is recorded in decimals; FRA regulations are noted in fractions.

least 0.1 inch or if the regulatory limit is exceeded for at least 3 feet.[19] The combination of profile and gage deviations measured at the POD provided an indication that remedial action was required for safe operation over that track, but because the measurements did not individually meet the exceedance criteria used by the geometry car, the location was not noted as an exception.

The last Metro-North track inspection in the area of the derailment was conducted on foot earlier in the day of the derailment. The inspection report did not identify any reportable track defects in the area.[20] However, consistent with the fouled ballast and inadequate drainage discussed above, the report noted, "MP 11.4, track 1 has a mud spot, MP 10.1, track 2 has a mud spot and a 1/2-inch profile deviation, MP 10.2, track 2 [has] two broken ties and surfacing [is] needed." The inspection record did not note any exceptions at the POD.

Track panels (sections of rail still attached to the ties) from the derailment site were preserved and disassembled. Wear in the rail seat area was noted on many of the ties along with a worn trough on the field side of the rail seat (see figure 19). Center cracking was also evident on a number of ties and the cross section of the ties was reduced by abrasion on the bottom of the ties (see figure 20). In addition, several ties were broken.

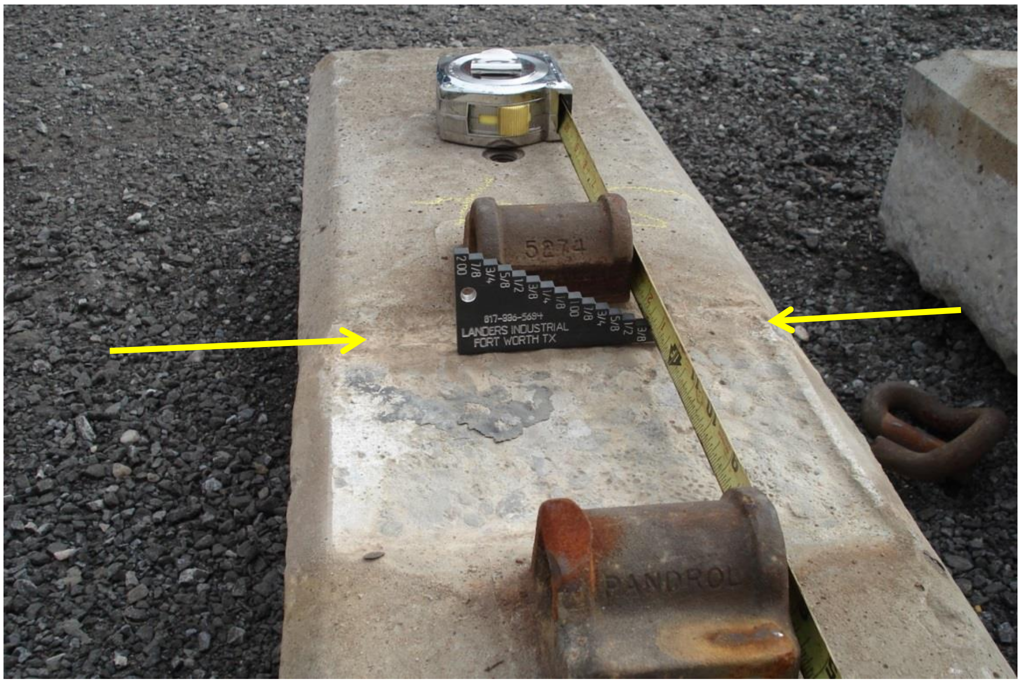

Figure 19. A tie from the POD area showing the groove worn into the field side of the rail seat. Yellow arrows highlight the groove location.

[19] The 0.1 inch exceedance is programmed to reduce the number of false positive indications. The geometry car takes measurements every foot with laser beam instrumentation, and the distance of 3 feet allows for signal dropout or spikes.

[20] Metro-North used the FRA track standards as the criteria for reportable defects.

Figure 20. Multiple cracks in the concrete ties between the rails at the POD. (Note: gage rod was installed after the derailment.)

The cross section of the ties was reduced by bottom abrasion. The reduced cross section was more pronounced on the end of ties along the inside of the curve. Steel tensioning strands were exposed on the ends of many ties (see figure 21).

Figure 21. Tie from the POD area (left) with reduced cross section and exposed tension strands and unused exemplar tie (right).

Five concrete ties from the POD area were sent to a lab for testing. The NTSB provided the Volpe National Transportation Systems Center (Volpe) with detailed information on the derailment and the concrete tie testing.[21] Volpe used this data to model wheel rail interaction at the POD. A range of car weights and loaded car centers of gravity (from the likely highest to the likely lowest) were modeled to determine the effects. The modeling indicated the primary factor in the derailment was the deteriorated condition of the track, and specifically, the combination of widening gage and profile deviation (a dip in the track).

[21] The Volpe Center is part of the Department of Transportation and its staff supported the FRA in this investigation.

The National Transportation Safety Board determined that the probable cause of the accident was excessive track gage due to a combination of fouled ballast, deteriorated concrete ties, and profile deviations resulting from Metro-North's decision to defer scheduled track maintenance.[22]

3.4 Derailment of Metro-North Train 8808 in The Bronx, New York, December 1, 2013

At 7:19 a.m. on December 1, 2013, southbound Metro-North passenger train 8808 derailed at MP 11.35 on main track 2 of the Metro-North Hudson Line (see figure 22). The train originated in Poughkeepsie, New York, with a destination of Grand Central Terminal. It consisted of seven passenger cars and one locomotive at the rear in a push configuration. The weather at the time of the accident was reported as 39°F, cloudy skies, and clear visibility.

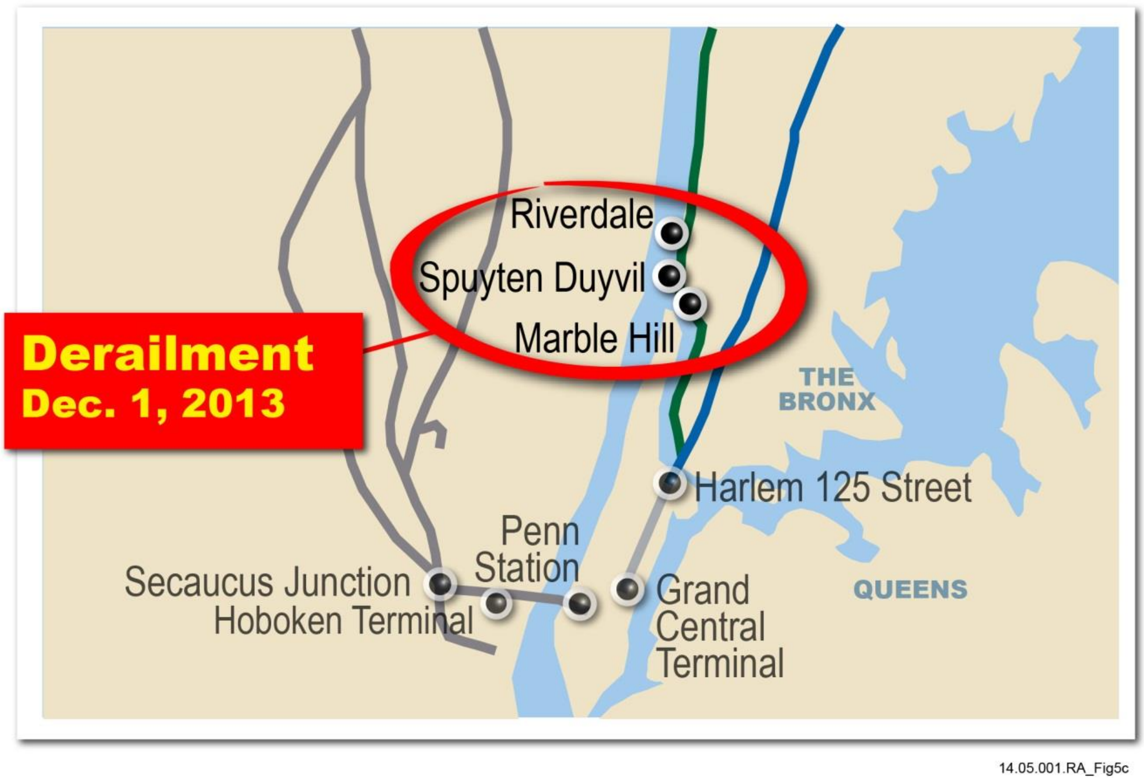

Figure 22. Excerpt from the Metro-North system map showing the December 1, 2013, Bronx derailment accident location.

All seven passenger cars and the locomotive derailed. The derailment occurred in a 6° left hand curve where the maximum authorized speed was 30 mph. The train was traveling at 82 mph when it derailed (see figure 23). Four passengers died and at least 61 other persons were

[22] The complete brief of the accident is attached to this report as Appendix C.

injured. Metro-North estimated about 115 passengers were on the train at the time of the derailment. Property damage was estimated at over $9 million.

The Metro-North crew reported for duty at Poughkeepsie, at 5:04 a.m. and departed at 5:54 a.m. The train made nine stops prior to the derailment; its last stop was at Tarrytown, New York, about 14 miles north of the accident curve.

Figure 23. Overhead view of derailed Metro-North commuter train 8808.

Upon passing Riverdale, about 2.5 miles north of the accident location, the engineer increased the train speed to the maximum authorized speed of 70 mph. He maintained full throttle and the speed further increased to 82 mph. Upon entering the 30 mph curve at MP 11.4, the entire train derailed. During the derailment sequence many of the cars slid on their right sides in the direction of travel and window glazing (panes) detached from the cars. Based on their resting locations, the extent of dirt and plant material present, and the severe nature of their injuries, investigators determined that all four passengers who died in the accident were completely or partially ejected from the train through window openings. In addition, at least two of the seriously injured passengers sustained injuries consistent with contacting the ground outside the train as the cars slid along the ballast.

Speed limits are listed by MP in Bulletin Orders issued to train crews and engineers are required to know the speed limits on the territory over which they operate. Also, trains are governed and authorized by a traffic control system with interlockings at strategic locations on the line.[23] Trains are equipped with cab signals and automatic train control (ATC). Allowable

[23] Interlockings are an arrangement of switches and signals where trains can be routed to other tracks.

speed information is transmitted through the rails to receivers in each train and displayed in the cab on an aspect display visible to the engineer. Four cab signal aspects may appear on the display: normal cab (allows up to the system maximum authorized speed of 80 mph), limited cab (45 mph), medium cab (30 mph), and restricted cab (15 mph). The ATC system applies the train brakes if an engineer fails to comply with the cab signal speeds displayed. The signal system was designed to prevent train-to-train collisions. It was not designed to prevent trains from exceeding speed limits. Signals requiring reduced speed are based on train occupancy or switch positions in advance of a train.

The accident train received a normal cab signal at the last control point (CP 12) prior to the derailment. This meant it was up to the engineer to comply with the 70 mph speed limit and slow to the 30 mph speed limit before entering the curve. The train brakes were not applied before the derailment. The engineer told investigators that he remembered feeling “dazed” or “hypnotized” just before the derailment.

Positive Train Control (PTC) is a system intended to prevent train-to-train collisions, overspeed derailments, civil speed restriction violations, movement through improperly aligned switches, and unauthorized train incursions into work areas. The NTSB has long advocated the installation of PTC on US railroads. No PTC system was installed in the area where this accident occurred. Federal statute requires Metro-North to install PTC by December 15, 2015.[24] Metro-North is currently in the process of developing a PTC system. Had PTC been fully implemented on Metro-North, it would have prevented this accident.

On December 11, 2013, the FRA issued Emergency Order (EO) 29 instructing Metro-North to identify appropriate modifications to its signal systems to enable warning and enforcement of passenger train speeds on main track where there is a speed reduction greater than 20 mph. Until the modifications were made, Metro-North was required to post a second qualified person in the cab as the train approached the speed restriction.

After the accident, Metro-North changed the signal system at CP 12, so the signal system would enforce the 30 mph speed restriction. Metro-North identified four other locations that met the EO criteria and modified the signal system to automatically enforce permanent speed restrictions at each of those locations.

3.4.1 NTSB Recommendations on Speed Restriction Signs and Recorders

As a result of this accident, on February 18, 2014, the NTSB issued the following recommendations to Metro-North:

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[24] Regulations at 49 CFR Part 236, subpart I, were developed as required by the Rail Safety Improvement Act of 2008 (RSIA).

R-14-07

> Survey your system and install approach permanent speed restriction signs where permanent changes in train speed apply, to alert train operating crews of the reduced speeds.

R-14-08

> Require the installation, in all controlling locomotive cabs and cab car operating compartments of crash- and fire-protected inward- and outward-facing audio and image recorders capable of providing recordings to verify that train crew actions are in accordance with rules and procedures that are essential to safety as well as train operating conditions. The devices should have a minimum 12-hour continuous recording capability with recordings that are easily accessible for review, with appropriate limitations on public release, for the investigation of accidents or for use by management in carrying out efficiency testing and systemwide performance monitoring programs.

R-14-09

> Regularly review and use in-cab audio and image recordings in conjunction with other performance data, to verify that train crew actions are in accordance with rules and procedures that are essential to safety.

On May 14, 2014, Metro-North responded to recommendation R-14-07 stating that in June 2014 it would place permanent speed restriction signs at ten locations on the Hudson, Harlem, and New Haven lines. Metro-North stated that those locations were identified because each allowed the maximum authorized speed approaching the speed restriction to exceed the restriction speed by more than 10 mph. The letter also stated that Metro-North planned to identify and place signs at similar locations on the New Canaan, Danbury, Waterbury, and West-of-Hudson lines.

On June 26, 2014, the NTSB replied that the recommendation was intended to alert operating crews in a consistent manner, and the NTSB was concerned that treating 5- and 10-mph reductions differently from higher reductions could have the unintended consequence of signaling to crews that overspeeding up to 10 mph is acceptable. The NTSB urged Metro-North to reconsider this approach and classified R-14-07 *Open—Unacceptable Response*.

On September 24, 2014, Metro-North responded that it was treating all speed reductions consistently, and stated that placing signs at all 900 permanent speed transition points would detract from engineers' ability to recognize Temporary Speed Limit and Working Limit signs. Further, Metro-North indicated it had analyzed additional operating risks and identified 25 additional locations where speed signs were needed, resulting in the placement of additional signs. In addition, Metro-North described its new enhanced speed enforcement program, which includes radar checks, on-board observations, targeted random event recorder download reviews, and mainline banner testing.[25] Finally, Metro-North stated it had reviewed all MP markers to ensure accuracy and consistency with its timetable. This will assist engineers in identifying the locations of speed changes on the system. Pending the completion of these efforts, which address the NTSB's concerns, Safety Recommendation R-14-07 is classified *Open—Acceptable Response*.

On May 14, 2014, Metro-North responded to R-14-08 and -09 stating that the MTA Board had authorized it to procure cameras with 12-hour continuous audio and image recording capability for the locomotives and operating cabs of its M-7 and M-8 equipment. The letter further stated the Metro-North Safety Department would work on integrating the data as part of the Metro-North System Safety Program Plan (SSPP), and the recordings would be used for training, efficiency testing, hazard analysis, and accident investigations. Metro-North has since advised the NTSB that it intends to install cameras on its entire fleet. On June 26, 2014, the NTSB classified Safety Recommendations R-14-08 and -09 *Open—Acceptable Response*.[26]

3.4.2 Medical Information

The NTSB reviewed Metro-North's medical protocols and its medical records for the engineer, as well as the engineer's personal medical records including: postaccident emergency department records, pre- and postaccident medical records, and the results from a postaccident sleep evaluation and polysomnography (sleep study). The engineer passed a preplacement physical for Metro-North on October 11, 1999. At the time, he was 32 years old, 5 feet 11 inches tall, and weighed 215 pounds. No body mass index (BMI) was recorded. He answered "no" to questions 25 ("Excessive Worry, Depression or Difficulty with Sleep") and 27 ("Excessive Weakness or Fatigue") on Metro-North's medical history questionnaire.

He passed routine follow-up physical exams for Metro-North in 2003, 2005, and 2008. On May 3, 2011, the engineer underwent his most recent routine physical. He again answered "no" to questions 25 and 27. His height and weight were recorded as 5 feet 11 inches and 246 pounds. No BMI was noted, but the health care provider noted "overweight" under "general physical appearance."

The engineer had been diagnosed with high cholesterol, gastroesophageal reflux disease, and pre-diabetes. On November 15, 2011, he visited his doctor's office and complained of fatigue. After some blood tests, the engineer was diagnosed with low testosterone. About a year later, he was diagnosed and treated for hypothyroidism. At his last visit before the accident in May 2013, the engineer's BMI was recorded as 38.21 kg/m2. Although the health care providers evaluated the engineer for fatigue and identified two potential causes, at no point during any of the preaccident evaluations did his health care providers document a discussion regarding snoring, interrupted sleep, daytime sleepiness, or his sleep pattern, suggesting they did not

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[25] Banner tests involve setting up a banner on the track in front of a train operating at restricted speed. If the train stops short of the banner as required, it demonstrates compliance.

[26] Metro-North has advised the NTSB that it plans to outfit its entire fleet of locomotives and cab cars with cameras.

consider the possibility of a sleep disorder causing the symptom. The health care provider notes indicated the providers knew their patient was employed as a train engineer.

After the accident, on December 4, 2013, the engineer's weight was recorded as 261 pounds and his BMI was determined to be 36.4 kg/m2.

Following the accident, the engineer underwent an evaluation by a Board-certified sleep medicine physician and a noninvasive sleep study. The engineer's Epworth Sleepiness Score was 12 (scores above 10 indicate significant daytime sleepiness and the need for further medical evaluation). Notes indicate that the engineer had a history of snoring. The sleep specialist also noted the engineer's recent work schedule change from late night to early morning shifts. A statement in the sleep specialist's report reads: "Being a shift worker might have contributed to the accident."

The sleep study found the engineer's apnea/hypopnea index (AHI) was 52.5 episodes/hour, indicating severe obstructive sleep apnea (OSA).[27] Continuous positive airway pressure (CPAP) was prescribed as treatment. During a follow-up evaluation to assess the effectiveness of the treatment, the record notes the engineer used the CPAP for nearly 7 hours on each of the previous 30 days and that he was feeling more energetic. His Epworth Sleepiness Score had decreased to 1.

Title 49 CFR 240.121 requires locomotive engineers meet hearing and vision standards. Federal regulations do not require any screening for sleep disorders. Additionally, the regulation requires that a "treating medical practitioner or a physician designated by the railroad" make a good-faith judgment that any medications used by an employee are consistent with the safe performance of employee job duties. The NTSB has previously recommended that the FRA add sleep disorder screening to the medical evaluation requirements for train crews. These recommendations are discussed in section 4.4.1.

3.4.3 Shift Work

During his interview after the accident, the engineer characterized his state before the accident as "dazed," "mesmerized," "hypnotized," and "like driving a long period of time in a car and staring at the taillights in front of them, and you get almost like that hypnotic feeling staring straight ahead." Additionally, he was unable to recall information about the accident trip after the train departed the Tarrytown Station stop, other than recalling the speed of the train at some point was about 62 mph. The engineer's description and lack of recall is consistent with

[27] An apneic episode is the complete absence of airflow though the mouth and nose for at least 10 seconds. A hypopnea episode is when airflow decreases by 50 percent for at least 10 seconds or decreases by 30 percent if there is an associated decrease in the oxygen saturation or an arousal from sleep. The AHI sums the frequency of both types of episodes. An AHI of less than 5 is considered normal. An AHI above 30 events/hour indicates severe sleep apnea.

someone not actively engaged in their task, such as a fatigued person who experienced a microsleep.[28]

About 2 weeks before the accident, the engineer's work schedule changed as a result of a routine job bid.[29] After more than 2 years working shifts beginning in the late afternoon or evening and ending in the early morning, the engineer began to work shifts that commenced in the early morning (4-5 a.m.) continuing through the early afternoon.

Adjusting to a new wake/sleep schedule can take days or longer, depending on the difference between the previous and current schedules and the quality of restorative sleep obtained. (Bjorvatn and others 1999)[30] The engineer told investigators that on his new work schedule he began to awaken around 3:30 a.m. and retire between 8:00 p.m. and 8:30 p.m. His wake/sleep cycle had now shifted about 12 hours. Additionally, the engineer reported that his wake and sleep times varied in the days preceding the accident, around the Thanksgiving holiday, which could have degraded his quality and quantity of sleep. Given the substantial shift in work schedules and the varied sleep/wake times, it is likely that the engineer had not adjusted fully to the new work schedule at the time of the accident. The engineer's OSA combined with his incomplete adjustment to a dramatic shift in his work schedule most likely resulted in him being fatigued at the time of the accident.

The National Transportation Safety Board determined that the probable cause of the accident was the engineer's noncompliance with the 30-mph speed restriction because he had fallen asleep due to undiagnosed severe obstructive sleep apnea exacerbated by a recent circadian rhythm shift required by his work schedule. Contributing to the accident was the absence of a Metro-North Railroad policy or a Federal Railroad Administration regulation requiring medical screening for sleep disorders. Also contributing to the accident was the absence of a positive train control system that would have automatically applied the brakes to enforce the speed restriction. Contributing to the severity of the accident was the loss of the window glazing that resulted in the fatal ejection of four passengers from the train.[31]

2.5 Metro-North Employee Fatality in Manhattan, New York, March 10, 2014

On March 10, 2014, at 12:55 a.m., a Metro-North electrician was fatally struck by northbound Metro-North train 897 near MP 3.2 within the CP 3 interlocking in Manhattan, New York (see figure 24). Three workers were attempting to re-energize the third rail on tracks out of service for maintenance (see figure 25). Two workers were able to jump clear of the approaching train, but the third worker was struck by the train and killed.

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[28] *Microsleep* is a brief, involuntary episode of sleep occurring during wakeful activity. Microsleep is a symptom of sleep deprivation and daytime sleepiness.

[29] As part of a collective bargaining agreement, Metro-North train crew work schedules are reopened for seniority bid twice each year.

[30] Bright light treatment is used for adaption to night work and readaption back to day life. A field study was performed at an oil platform in the North Sea.

[31] The complete brief of accident is attached to this report as Appendix D.

Figure 24. Excerpt from Metro-North system map showing the Manhattan accident location.

Figure 25. View of the accident location looking north. The striking train was coming from the left through the crossover to enter the track in the middle of the photograph. The yellow arrow shows the route of the train.

A track switch at CP 3 connecting tracks 1 and 3 required replacement. Metro-North planned the replacement to begin on Friday evening to reduce impacts to passenger service. Work crews obtained track authority for main tracks 1 and 3 from CP 2 to CP 3, meaning that sections of track were removed from service. This provided exclusive use of the tracks for maintenance and on-track protection from train movements.[32] In addition, the assistant track supervisor received authority from the RTC for main tracks 1 and 3 within CP 3 from the south end of the CP 3 interlocking to a dividing line within the interlocking referred to as the "A/B split." There is no sign in the field to mark the A/B split although there are infrastructure features that allow knowledgeable workers to identify the A/B split location; however, many electrical workers were not aware of the A/B split.

The A/B split is near the middle of the CP 3 interlocking and separates the signal system but not the third-rail power system. Using the A/B split as a limit for the on-track protection allowed the RTC to block/lock switches at one end of the interlocking but still use the switches at the other end on the same track for train movements. (see figure 26.) Using the A/B split as a limit of track authority was normal practice for the signal and track departments. However, during interviews with NTSB investigators, the power department employees, including the electricians, said that they were less familiar with the location and the use of the A/B split as a limit of track authority.

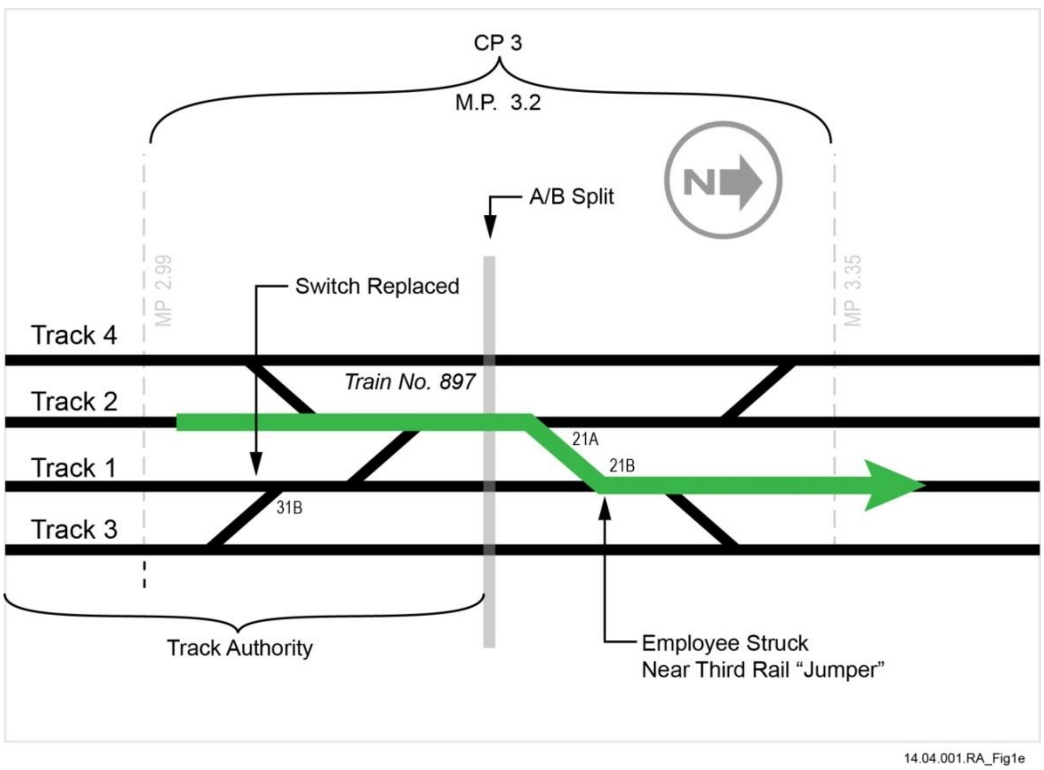

Figure 26. Diagram of CP 3 interlocking. The green arrow indicates route of the striking train.

32 Roadway worker regulations require a clear understanding of the form of on-track protection provided for a work area.

The assistant track supervisor held a job briefing Friday evening explaining the on-track protection he had obtained for the pending work. The track supervisors, the signal supervisor, and the power department supervisor attended. These supervisors were responsible in turn for providing a job briefing to the crews from their respective departments. Before starting the work, the third-rail power was de-energized for main track 1 within the CP 3 interlocking. This removed the power from main track 1 up to, but not including, the 21B switch at the north end of the interlocking. As noted above, the A/B split had no effect on the third-rail power.

Although track authority protection ended at the A/B split, the power department supervisor incorrectly believed the authority extended further. He told NTSB investigators he believed power would be de-energized within CP 3 on track 1 through switch 21 B.

Just after midnight on the day of the accident, the assistant track supervisor and the power department supervisor discussed the work to be performed at CP 3. The power department supervisor said he recalled the assistant track supervisor telling him track authority was "the same thing that we had Friday night"–nothing had changed. The power department supervisor in turn told the power department foreman protection (authority) was in place on main track 1 all the way through CP 3. The power department foreman wrote this (incorrect) information on his Roadway Worker Briefing Form.

During interviews, investigators asked the electricians where they thought they had track protection. Each answered the same way, indicating they thought they were protected on main track 1 "at" CP 3, meaning their authority was within the entire area covered by CP 3.

Based on their understanding of authority limits (what area was protected), the power department foreman and the two electricians walked along the track to connect a jumper (electrical connection) adjacent to the 21B switch. This was actually outside the authority limits that had been in place since Friday night.[33]

The power department foreman and the two electricians finished connecting the jumper and were removing a service tag when the northbound train approached on track 2. The two surviving employees said that at first they were not alarmed by the approach of the train because they believed they had protection (were within authority limits) on main track 1. As the train came closer and the engineer blew the whistle they realized the train was coming through the crossover and entering the track where they were standing. The two workers yelled to each other and jumped toward main track 3.

While traveling about 40 mph, the engineer said he saw three workmen near the far end of the crossover he was entering and blew the whistle as a warning. When halfway through the crossover he said he realized the workers were in danger and applied the emergency brakes. He witnessed two of the workers jump away from the tracks but not the third. The third worker was struck and killed by the train.

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[33] It should be noted that track authority protects workers only from train movements, not electrocution, which is addressed through other means such as protective equipment, including gloves, boots, and face shields. The electricians in this case were using the required protective equipment.

In summary, the assistant track supervisor had track authority (protection from train movements) on main tracks 1 and 3 south of CP 3 and extending within the CP 3 interlocking up to the A/B split. He relayed this information to the power department supervisor. The power department supervisor relayed an abbreviated and incorrect version of the track authority limits to the power department foreman. The power department foreman relayed this incorrect information to the electricians. All of the power department electrician interviewees stated they thought they had protection on main track 1 "at" CP 3 which they took to mean that the work area was protected from train movements within the entire interlocking, when in fact they did not and were working outside the protected area.

As discussed earlier, following the West Haven employee fatality Metro-North implemented an electronic system known as EEPS to enhance existing procedures designed to prevent train incursions into work zones. This system was operational on the day of the accident; however the location where the electrician was struck was outside the limits of protection, so it was not the type of event that the EEPS was designed to prevent.

The *Metro-North Roadway Worker Safety Manual*, effective February 13, 2011, included the following section outlining job briefing requirements:

> 3-A A job briefing must be held prior to fouling a track, and any time that there is a change in on track safety.[34] All Roadway Workers must participate in this job briefing.
>
> 3-B A job briefing must include:
>
> 1. The identification of the Roadway Worker in Charge
>
> 2. The general plan and procedures for the work to be performed
>
> 3. *The on-track protection methods that will be used including the means of on-track protection being provided and the limits of the protection.* [emphasis added]
>
> 4. Definite work assignments
>
> 5. The predetermined place of safety where roadway workers are to clear for trains or equipment
>
> 6. The status of adjacent tracks, including the MAS [maximum authorized speed] and whether on-track protection is required for the work to be performed

[34] In this context, on track safety means a change in the type of protection or authority.

The *Metro-North Operational Testing Plan Manual* described the purpose of monitoring roadway workers receiving on-track protection and roadway workers receiving a job briefing as follows:

> This test checks compliance by roadway workers with the general requirements of Metro-North's on-track safety program, including the individual's responsibility for following the program.[35]
>
> This test checks compliance by roadway workers with the requirement to participate in a Roadway Worker Protection job briefing prior to performing any task that requires fouling a track or has the potential to foul a track.

There were no records of monitoring the proper performance of job briefings among electricians, foremen, or supervisors. Furthermore, there were no records of supervisors having received training to become qualified to conduct such monitoring.

The National Transportation Safety Board determined that the probable cause of the accident was the miscommunication of the limits of on-track protection resulting from incomplete and inaccurate roadway worker job briefings. Contributing to the accident was use of a reference point for on-track protection (the AB split) that was poorly understood by some of the workers on the track.[36]

3.5.1 Postaccident Actions

Metro-North instituted an employee work stand-down following the accident. On March 11, 2014, a meeting for more than 340 employees was held. The agenda included the importance of daily job briefings and the use of the Metro-North safety hotline to report safety issues. Metro-North advised investigators it is developing and implementing a nonpunitive roadway worker protection peer auditing process that includes union participation.

Metro-North also discontinued the use of the A/B split as a limit for most on-track protection and on March 20, 2014, issued the following prohibition on the use of the A/B split as a working limit when obtaining on-track protection:

> The use of an "A/B Split" or "B/C Split" as a "Working Limit" is not to be granted in the application of roadway worker protection within an interlocking for all Crafts other than qualified Signal Department Employees.

[35] Tests involve observing employees engaged in work tasks and recording whether they comply with operating rule requirements. When they do not comply, managers are required to provide coaching, retraining, or some form of disciplinary action.

[36] The complete brief of this accident is attached to this report as Appendix E.

4 Organizational Factors

The NTSB routinely assesses the role of an organization's safety policies, management, and oversight during its investigations, and has on a number of occasions recognized organizational deficiencies as contributing to an accident. Recent examples include the fatal collision of two Washington Metropolitan Area Transit Authority Metrorail Trains on June 22, 2009 (NTSB 2010); a fatal aviation accident on February 12, 2009, involving Colgan Airlines while on approach to Buffalo-Niagara International Airport (NTSB 2010b); the fatal natural gas pipeline rupture in San Bruno, California, on September 9, 2010 (NTSB 2011); and the hazardous liquid pipeline release in Marshall, Michigan, on July 25, 2010 (NTSB 2012).

After the Bridgeport and West Haven accidents for Metro-North, it became apparent that organizational factors were involved. In November 2013, the NTSB held a 2-day investigative hearing that focused on key safety issues from those two accidents, so that the entire industry could benefit from the lessons learned. Some of the issues examined were: Metro-North's track inspection and maintenance procedures; the crashworthiness of the Kawasaki M-8 railcars during the Bridgeport derailment and collision; operational measures to ensure on-track work zones were protected from undesired train movements; the state of Metro-North's organizational safety culture and how it could be strengthened; corrective actions Metro-North has implemented since these two accidents; and the role and effectiveness of federal regulation and oversight in all of these areas. The hearing addressed these issues through four panels: (1) Metro-North track maintenance and inspection; (2) the crashworthiness of the Kawasaki M-8 railcar; (3) operational protection of on-track work areas; and (4) Metro-North's organizational safety culture.[37]

Following the December 1, 2013, fatal derailment in The Bronx, the FRA launched its own assessment of Metro-North operations and safety compliance, called Operation Deep Dive. With assistance from the FTA, the FRA reviewed the Metro-North safety-related processes and procedures, compliance with safety regulations and requirements, and overall safety culture. The FRA Deep Dive report cited three overarching safety concerns affecting Metro-North: "1) an overemphasis of on-time performance, 2) an ineffective Safety Department and poor safety culture; and 3) an ineffective training program." These findings echoed an earlier self-assessment offered by the incoming president of Metro-North that "it's a culture that felt the number one priority was on-time performance," and, "I think there was a culture that didn't believe that their safety was the number one priority." On August 27, 2014, the MTA released its BRP final report. The report outlined the BRP's concerns about the Metro-North safety culture, track maintenance program, overemphasis on on-time performance, and succession planning.

Dr. James Reason in *Managing the Risks of Organizational Accidents* (Reason 1997) suggests that one limitation of accident investigations and the identification of causes is that they stop at the point when they are no longer controllable by the organization conducting the investigation. This was the case for both the internal investigations conducted by Metro-North, which focused only on Metro-North activities. The MTA BRP addressed Metro-North, MTA,

[37] A complete transcript of the hearing is available in the public docket for the Bridgeport accident (accident number DCA13MR003) on the NTSB website.

and two other railroads subject to MTA oversight—the Long Island Railroad and New York City Transit (subway). The FRA Deep Dive investigation findings and recommendations were limited to Metro-North. The FRA had no findings with respect to MTA or the FRA's regulation of MTA and Metro-North.

This NTSB Special Investigation addresses findings with Metro-North and MTA, as well as findings relevant to the role of FRA and the medical community in these accidents. To the extent the FRA and MTA BRP findings cover areas investigated by the NTSB, they were generally consistent with the NTSB findings.

4.1 Safety Culture and Safety Management

Discussion about organizational culture and climate increased during safety research in the 1970s and 1980s—most of which was not specific to transportation.[38] The term "safety culture" gained widespread attention following the 1986 Chernobyl accident.[39] The British judicial inquest into the sinking of the ferry *Herald of Free Enterprise* off the coast of Belgium the following year highlighted the role of organizations in the cause of transportation accidents (Her Majesty's Stationery Office 1987). Safety culture deficiencies have since been cited as contributing to several high-profile accidents, such as the space shuttle Columbia accident in 2003 (Columbia Accident Investigation Board 2003), the BP Texas City refinery explosion in 2005 (CSB 2007), and the Deepwater Horizon Macondo well blowout in 2010 (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling 2011).

The concept of safety culture is now routinely discussed in a variety of industries, including across all modes of transportation. Many of the modal agencies of the US Department of Transportation (DOT) and modal industry groups now publish resources related to the role of safety culture in preventing accidents and injuries (FRA 2014) (Transportation Research Board 2007) (AGA 2011).

Despite the widespread use of the term, there is no universally accepted definition of safety culture (Guldenmund 2000). However, in his 1997 book, Dr. Reason described a five element model of safety culture that has been widely cited and helped popularize the safety culture construct (Reason 1997).[40] Other researchers have offered a wide variety of competing

[38] For example, research conducted by the then newly formed National Institute for Occupational Safety and Health demonstrated the link between an organization's safety programs and its accident rate, see (Cohen 1975). Other work attempted to define and measure elements of an organization's safety climate. (Zohar 1980).

[39] An International Atomic Energy Agency summary report on the 1986 Chernobyl accident used the term safety culture to describe the safety system that should be expected, but was found lacking. In a later report on the topic, the International Nuclear Safety Group traced the development of a safety culture to national safety regulations that establish a chain of responsibility and authority for maintaining the required level of safety in an organization, through the operating policies of that organization.

[40] Dr. Reason's model includes an *informed culture* that collects and analyzes relevant information; a *reporting culture* where people have confidence to report safety concerns without fear of blame; a *learning culture* where people are able to learn from mistakes and make changes; a *just culture* in which errors and unsafe acts will not be punished if the error was unintentional; and a *flexible culture* capable of adapting to changing demands.

models (Pidgeon and O'Leary 1994).[41] Practitioners and regulators have also suggested their own models, such as the Nuclear Regulatory Commission's nine traits of a positive safety culture (*Federal Register* 2011, 34773). In his opening presentation to an NTSB symposium on Corporate Culture in 1997, Dr. Reason offered an observation that, "few phrases are so widely used yet so hard to define as 'safety culture'" (Reason 1997b).

In September 2013, the NTSB held a two-day forum on safety culture in transportation that included researchers, operators, labor groups, and regulators to discuss their experiences managing safety in their operations. Forum participants acknowledged the difficulty of defining and measuring safety culture. One of the researchers, Dr. John Carroll, Professor of Organization Studies and Engineering Systems at Massachusetts Institute of Technology offered the following caution:

> The focus on safety culture is not without risks. All of these analyses may generate some good conversations and even regulations, but there's also a risk of increasing cynicism if all this comes to nothing on the ground. If it's just words and it's just check the box and nothing is really changing where people work, then they begin to hear safety culture as another way of just hiding the behaviors that we do all the time and … it's ceremonial or even deceptive, and … if we're not seriously making progress and understanding how to do that, it may make it even harder to manage process safety.

The NTSB explored the issue of safety culture at Metro-North during its November 2013 investigative hearing on the Bridgeport and West Haven accidents. During a panel discussion on the topic of organizational safety culture, Dr. Richard Hartley of B&W Pantex expressed a related concern:

> the focus on and the term safety culture confuses a lot of people, to the point where most management teams are actually paralyzed by it because it's deemed to be an abstract, squishy kind of subject …And again, that's why I keep on contending that the problem is not the safety culture. The problem is the work environment. And that's one thing that leadership can change, should change, and I would contend that's Leadership 101, which a lot of people tend to have forgotten. But…what used to work, I would say go back and revisit because a lot of those values you had back when you really understood what leadership was all about still apply today.

Rather than focus on defining safety culture or the difficulties of measuring it, the companies that participated in the NTSB safety culture forum suggested safety benefits from applying similar techniques to manage organizational factors related to safety. Companies of all sizes and representing various modes of transportation cited safety benefits from efforts related to organizational communication and management structure, personnel selection and training,

[41] For example, Pidgeon and O'Leary described an effective safety culture as having at least four factors, including a senior management commitment to safety; shared concern for hazards; realistic and flexible norms about hazards; and continuous hazard monitoring, analysis, and feedback systems.

reporting and monitoring systems, risk management systems, and external reviews and audits. These are all techniques typically cited as indicative of an effective safety culture.

NTSB investigators examined the organizational factors related to this series of accidents involving Metro-North by focusing on the Metro-North work environment and management of safety risks. Investigators interviewed employees from all levels of the company, reviewed the Metro-North oversight functions, organizational structure, employee training, and programs and procedures for safety risk management. NTSB investigators also examined the role of the MTA Board and FRA in assuring safety of operations at Metro-North. In some cases, investigators identified safety concerns that were causal or contributory to one or more of the five accidents included in this report. In other cases, the NTSB identified safety issues that may not have directly contributed to one of the five accidents, but represent a risk for future accidents if not addressed.

Taken as a whole, the organizational factors and associated safety issues identified in these accidents are consistent with the concerns expressed by the FRA, the MTA BRP, and the new president of Metro-North about safety culture at Metro-North prior to 2013. The NTSB is encouraged that Metro-North, the FRA, and the MTA BRP have acknowledged the organizational influences associated with the recent series of accidents. However, to avoid any misunderstanding about these organizational factors, the NTSB wishes to clearly identify the specific safety concerns found in its investigation of these events and the mitigations necessary to prevent recurrence of similar events at Metro-North and other railroads.

The following sections describe the Metro-North, MTA, and FRA safety policy and program weaknesses identified during the NTSB investigations of the five accidents in this report. Further, they discuss how Metro-North and MTA emphasis on personal injury and on-time performance as measures of system health, without adequate consideration of other operational safety concerns, resulted in a failure to identify emerging safety risks with Metro-North operations and infrastructure.

4.2 Metro-North Organizational Factors

4.2.1 Metro-North Safety Policy and Programs

The New York State Public Transportation Safety Board (PTSB) requires Metro-North and other MTA properties to maintain an SSPP and update it every 2 years. The Metro-North SSPP document describes procedures for all departments to update their specific safety plans and for providing these updates to the Safety and Security Department for inclusion in the consolidated Metro-North plan. The Safety and Security Department is then responsible for submitting the updated SSPP to the PTSB, FRA, and the American Public Transportation Association (APTA).

Metro-North maintains its SSPP to: “coordinate a safety system for prevention, identification and management of hazards in an effort to minimize safety risks to both customers and employees.” (MTA 2011) The Metro-North SSPP defines the roles and responsibilities for each division of the company, and documents the procedures necessary to comply with regulations and satisfy requirements of its oversight agencies. Specifically, the SSPP incorporates training, qualification review, certification, operational tests, and inspection procedures for compliance with 49 CFR Parts 213, 214, 217, 219, and 240; accident and incident investigation; emergency response; environmental management; and workplace safety programs. The Metro-North SSPP also describes the associated recordkeeping procedures.

The SSPP document also describes the Metro-North organizational structure, and the roles and responsibilities of each department and leadership position. According to the SSPP, the Metro-North president, senior vice president of operations, and the chief safety and security officer are responsible for overseeing the SSPP.[42] The Safety and Security Department is responsible for developing and administering all safety, occupation health, fire prevention, and security programs under the SSPP. Each of the departments and processes are described in the SSPP, including details of their interface with the Safety and Security Department. As part of this framework, each department of Metro-North is expected to develop a safety action plan to manage its responsibilities as defined in the corporate SSPP, tailored to the unique operating environment and work of that department.

The Metro-North SSPP describes specific programs for managing workplace, passenger, and public safety. The SSPP describes the Metro-North Priority One program as the core of its safety programs, focusing on the safety of employees.

As described in the SSPP, the Priority One program is intended to address employee safety concerns and identify hazards for correction through a system of local safety committees. Local safety committees are composed of represented (union) employees and local managers. The SSPP requires that safety concerns that cannot be addressed by a local committee should be reported to a district operations services committee. District operations services committees are made up of supervisory employees, both represented and nonrepresented, from the six Metro-North districts.[43] The union's local chairperson participates in the district committee meetings. District committees are also responsible for tracking all injuries in their district, and resolving identified hazards. The Priority One program is managed at the highest level by a Senior Management Safety Committee made up of the senior vice president of operations; chief safety officer; assistant vice presidents of operations services and mechanical and maintenance of way; and chaired by the president of Metro-North. Currently, there is no union participation at this level; however, Metro-North has advised the NTSB that it is looking to re-establish union participation in the executive safety committee.

[42] Organizational changes at Metro-North made in response to the recent series of accidents resulted in a separation of the safety and security management functions and the title of this position was changed to chief safety officer. Throughout this section, the titles of chief safety and security officer and chief safety officer should be considered synonymous.

[43] The six districts are Grand Central Terminal, Harmon, North White Plains, Brewster, Stamford, and New Haven.

Priority One program documentation includes descriptions of safety training, reviews, and incentive programs. Examples include:

- Individual and work group incentive programs to recognize and reward employees for being injury free
- Safety training and audit training for supervisors and managers
- Individual and work group safety reviews and risk reductions programs

4.2.2 System Safety Program Plan

The Metro-North 2011 SSPP, which was in effect at the time of the five accidents, asserts in its policy statement that, “Metro-North’s commitment to the SSPP will permeate every aspect of railroad operations.” The Metro-North director of operating rules provided NTSB investigators with the following assessment of the SSPP:

> Our 31-year history has shown significant improvement in reducing accidents and injuries … most of that is attributable to our System Safety Program taking a holistic view at what the railroad does. So I would say that over the last 31 years that the–prior to having a System Safety Program and since then, that it has been effective.

However, NTSB investigators found little evidence that Metro-North systematically followed hazard identification, assessment, and risk reduction procedures as described in the SSPP. Moreover, the NTSB investigators found no evidence that Metro-North actually used the SSPP as part of is operational guidance. Aside from senior management personnel, most of the Metro-North employees interviewed by NTSB investigators stated that they had never heard of or seen copies of the SSPP. When asked about the effectiveness of the SSPP in light of this discrepancy, the chief safety officer stated:

> I think there’s limited effectiveness of that System Safety Program Plan and part of that is the knowledge [of] how widely it’s been used or distributed, was it the basis for anything really, other than complying with the APTA.[44] And I don’t know if it’s that harsh, that it was absolutely not effective or not used for anything other than compliance with that, but it’s certainly not something I was ever educated on either. So…nobody sat me down and said, “This is the System Safety Program Plan, this is what it’s for, this is why we do it.”
>
> I don’t think it’s effective at all. I think, … my whole 28 years here it was something that we reviewed when APTA and the FRA came in to do their triennial audit. We would distribute it to the corporate leadership team or the department heads when we'd sign off on it, and that was every couple years; I think it was every 2 or 3 years we’d—it was every few years we'd dust it off,

[44] APTA is an industry association. Compliance with any APTA protocols or standards is voluntary.

> reread it, maybe change a couple of names and department restructuring, some responsibilities a little bit, distribute it, and then it would get maintained just the—well, the appendices would get maintained in our office, and actually used to just reside out in the hallway there in the file cabinet. It would take up the whole cabinet, all of the appendices in it. So, I think we recognize that it was not very effective.

4.2.3 Priority One Safety Program Effectiveness

Metro-North officials acknowledged similar concerns with the effectiveness of the Priority One safety program. Similar to the SSPP, most of the employees interviewed were unable to describe the Priority One safety program beyond recognizing it as a slogan that appears on posters and brochures with the railroad’s logo. The program was intended to use structured layers of safety committees to facilitate a shared understanding of safety risks throughout the various layers of the organization and feed unresolved safety concerns upward through the organization for resolution. Meetings were intended as a tool to allow the district safety groups to speak directly with the president about safety actions plans and needs.

But in practice, interviews revealed operations division staff members were reportedly hesitant to have real discussions and present information in front of the president if it could have negative consequences. The Metro-North safety officer acknowledged that meetings generated reports without any meaningful review or discussion of safety concerns:

> [T]hey had been essentially given a script by the operations division because they were all operating people, you know, what to report on: These are your numbers, this is what you did, this is how well you did, and these are the good things you’re going to do, and there wasn’t a lot of conversation; it was just a report. And they would call it a dog and pony show and they’d come down and—there was never a lot of good conversation.

The intent of the Priority One program may have been to facilitate the efficient resolution of employees’ safety concerns, but the distribution of program functions resulted in no one entity being aware of or responsible for managing safety issues. As a result, the different divisions of Metro-North were responsible for managing the safety of their respective functions.

The NTSB concludes that Metro-North did not effectively use its SSPP or Priority One program for their intended purposes of providing guidance for managing the safety of the Metro-North operations and employees.

4.2.4 Safety Department Effectiveness

During interviews with NTSB investigators, Metro-North employees expressed uncertainty about the functions and role of the Safety Department. One employee described the Safety Department as an “invisible department.” Another mentioned that the department “printed brochures.” One engineer with more than 20 years at Metro-North could not recall ever seeing a safety officer on his train, particularly not in his cab. Other employees mentioned unsuccessfully trying to get safety glasses, and questioned why safety officers did not conduct observations and oversight to ensure compliance with workplace safety policies.

All of the issues and functions attributed to the Safety Department were focused on personal injuries and occupational health issues. During an interview with NTSB investigators, the Metro-North medical director and medical review officer reported working closely with the safety department on tasks like developing guidelines for vision and hearing, respirator fit testing, lead exposure, and hearing protection issues. These worker protection efforts were apparently effective because the number of injuries reported annually at Metro-North had been decreasing for many years, and the number of incidents reported in 2012 was half of that reported in 2000.

While injury prevention is an important function of safety management, studies of significant accidents in other industries have shown that an improving injury record can sometimes mask unrecognized and unaddressed operational hazards. In fact, Emeritus Professor Andrew Hopkins concludes that "Reliance on lost-time injury data in major hazard industries is itself a major hazard." (Hopkins 2000)

NTSB investigators found no indication of the safety department being involved in operational or process safety functions. Testimony offered in the NTSB hearing by the then-president of Metro-North and the chief safety and security officer, indicated that the safety department was not historically involved in risk assessments for operational decisions. For example, when asked about the change from a four-track system to a two-track system in the Bridgeport derailment area prior to the accident, Metro-North management stated that no formal process was used to assess the risks associated with concentrating operations on fewer tracks, and no changes were made to the inspection or maintenance procedures in response to the increased load. Rather, the chief safety and security officer stated that it had no formal risk assessment process and that the operating division had "intuitively done that in the past".

This is concerning, especially in light of the fact that, on paper, the Metro-North Safety and Security Department has overall authority and responsibility for implementing and maintaining the SSPP. The SSPP describes the Safety and Security Department's role as follows:

> The Safety and Security Department has taken responsibility for the overall auditing, monitoring and assessment of our System Safety Program Plan. This responsibility relies heavily on the safety compliance measures that every department takes.

Further, interviews with Metro-North operating managers indicated that internal safety audits as described in the SSPP were not being conducted. When asked about the audits of operating departments, the chief of the Safety and Security Department responded: "I don't think we ever really did (them)."

The Metro-North assistant vice president–chief engineer explained the plans for future internal quality control audits as follows:

> Presently, prior to the [Bridgeport] derailment, we did not have anybody doing a QC audit of our installations in the track department. Part of our reorganization within track, there is going to be a quality division who is going to do quality checks on all inspectors' installations to ensure it complies with our installations.
>
> Internally, we're going to do our own auditing processing that will be documented and ensure that all the inspectors get audited over some frequency over a period of time.

The NTSB concludes that the Metro-North Safety and Security Department was ineffective in identifying and resolving operational or process safety issues across its departments, and that the organizational structure of Metro-North and its safety programs did not support effective safety risk management of all its departments and functions.

4.2.5 Risk Management and Safety Assurance

A typical risk management program includes formal procedures for identifying hazards, assessing risks, and creating risk controls. Once these controls are established, they are continuously monitored to evaluate their effectiveness and to search for new hazards.[45] The Metro-North SSPP includes discussion of the elements of risk assessment, including accident and incident investigation, and safety data acquisition and analysis. However, as further discussed below, the NTSB investigations identified deficiencies in the Metro-North safety risk management functions.

Incident and Close-Call Investigations

Accidents, incidents, and close calls provide the most concrete evidence of safety management deficiencies. Many safety management functions involve prevention of anticipated safety problems; accidents, incidents, and close calls represent known failures. By investigating the circumstances of these events, operators can identify the source of safety lapses and establish physical, technological, and procedural controls to prevent their recurrence.

Two of the accidents included in this report, the train derailment at Bridgeport and the employee fatality at West Haven, were preceded by similar events that provided Metro-North missed opportunities to identify and address safety deficiencies that played a role in the later accidents. The broken joint bar at Bridgeport was preceded by a track failure at the same location 43 days before the accident. On April 4, 2013, Metro-North track inspectors found broken joint bars at the same location. Track inspectors at that time also documented that the track was pumping under load. The broken joint bars were replaced and the area was hand tamped to

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[45] For an example of a formal risk assessment process, see the US Department of Defense hazardous risk identification and assessment process specifications of MIL-STD-882E *Standard Practice for System Safety*, dated May 11, 2012.

correct the pumping condition. Metro-North track inspectors again documented a pumping condition and inadequate ballast support at the same location again 2 days before the accident, but no corrective actions were taken.

The track foreman fatality at West Haven on May 28, 2013, was also preceded by a similar close-call incursion roughly 3 weeks prior. On May 4, 2013, an RTC controller inappropriately removed electronic block protection and cleared a train through an area occupied by track workers. The track foreman avoided injury in that case and reported the close call to the RTC. Despite a statement by the assistant vice president–chief engineer at Metro-North during the NTSB hearing that he expected that the investigation into this event would have resulted in a 20-page report, documentation of the event was limited to a 1-page memo with a timeline of events. He explained that a typical investigation on Metro-North involved a written report “detailing exactly what happened, what occurred, why it occurred, [and] corrective actions.”

In response to the earlier close call, Metro-North instituted additional operation control procedures, including a software enhancement that requires RTCs to validate their intent to release track authorizations before the RTC removes the blocking devices.

Thus, in both cases, the Metro-North analysis and response to the precursor events did not lead to the establishment of adequate controls to prevent their recurrence. The NTSB concludes that Metro-North did not effectively investigate accidents and incidents and address known deficiencies to continuously improve and revise processes to prevent recurrences.

Safety Data Monitoring

Apart from accidents and close calls, operators can identify potential safety deficiencies by monitoring their operations for undesired or unexpected circumstances and events. If Metro-North had effectively monitored track and other data, it could have identified the potential for serious accidents to occur.

Track Data

NTSB investigators reviewed 18 months of Metro-North track inspection records and identified a trend of increasing joint bar failures during the period of January 2012 to June 2013.

The NTSB investigation into the Bridgeport derailment revealed how track data monitoring could have been used to improve safety and prevent an accident. As discussed previously, the derailment was at the same location where a joint bar had broken 2.5 months earlier and the ballast had to be hand tamped to better support the track. Pumping and hanging ties at the location of a previous break should have served as a red flag to track maintenance personnel. NTSB investigators were able to identify an uptrend in broken joint bars on Metro-North by simply reviewing track inspection reports. But Metro-North missed the opportunity to identify a rising trend in broken joint bars and the risk of a repeat break at the derailment location by failing to analyze and act on its own data (see figure 27).

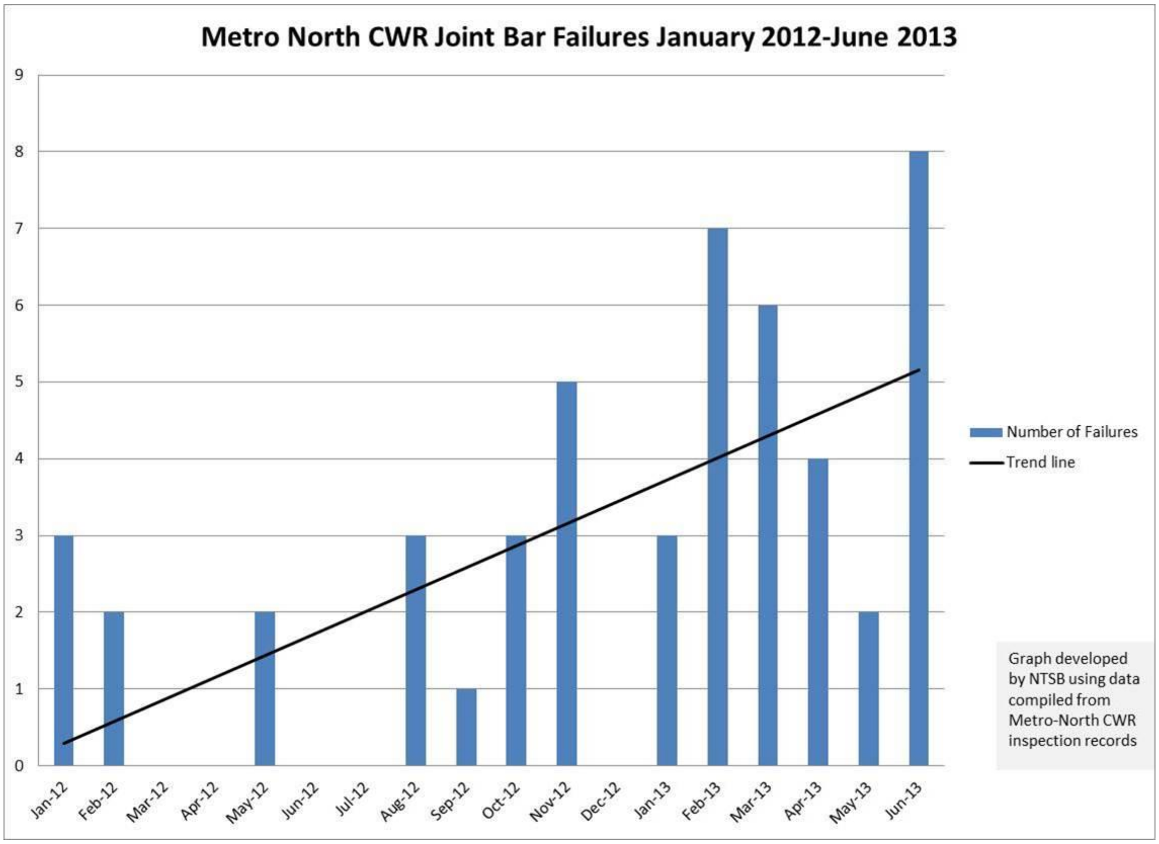

Figure 27. Joint bar failures on Metro-North.

Three automated track inspection technologies discussed at the NTSB hearing involve the use of track geometry vehicles, gage restraint measurement systems (GRMS), and automated joint inspection systems.

Investigators interviewed the Metro-North senior vice president of operations who had been appointed to that position just prior to the Bridgeport derailment. He had previously been the Metro-North chief mechanical officer in charge of rolling stock. He observed that as the chief mechanical officer he relied on a computerized asset management system that was:

> geared towards capturing failure data, capturing repair data, using it as a work order process-based system by which we could schedule and plan work and keep track of defects from cradle to grave.
>
> Early on, I became gradually aware that those systems or those types of departmental systems really did not exist. Within [the maintenance-of-way department], a lot of the inspection data was still paper based. There was no transition of paper-based documents to any type of electronic database.
>
> I noted there was very little opportunity to generate reports or do audits on a maintenance [of-way] function.

Track geometry vehicles are on-rail vehicles that measure various track geometry parameters such as gage, cross level, degree of curvature, and warp. In some cases, track on-rail vehicles are outfitted with GRMS. A GRMS applies forces to the track to yield measurements that are more representative of actual track behavior under load. Track geometry vehicles provide electronic data to railroads at a level of detail not possible using visual inspections alone. In addition to greater detail, the data from subsequent runs can also be compared to provide trending information over time and better assist railroads in prioritizing and planning track maintenance work.

At the NTSB hearing, the New Jersey Transit (NJT) chief engineer of track told the NTSB that the NJT found it cost effective to purchase a track geometry vehicle for its exclusive use and to run it over their system on a monthly basis. He went on to elaborate on the benefits:

> The car measures and calculates the track every foot. There’s no way that a track inspector can ever do anything coming close to that. Also, some of the things that you’re looking at, particularly on welded rail, you cannot see no matter how good an inspector you are. Alignment changes, in a curve in particular, are just very, very, very difficult to detect visually, while a track geometry car can do that for you. I mean, that’s been the biggest advantage.
>
> We’re also able to eliminate some other redundant inspections like quarterly curve gauge inspections. If we’re running the geometry car monthly, we don’t have to send an inspector out.
>
> We have not come across a downside to operating the geometry car.

He explained that after the track geometry inspection program was under way, the NJT was able to reduce the number of walking/hi-rail inspections to once per week (with an FRA waiver on required inspection frequencies). He went on to explain how the track geometry data also provided the opportunity to schedule maintenance more efficiently.

> Unlike Metro-North, we don't have a regularly scheduled maintenance surfacing program. We do that strictly geometry based. Like everyone else, there are resource issues. But because the numbers have been increasing and we can see them in our data, we have in fact started to put together a maintenance surfacing program to address these issues as they’ve come up.

Automated joint bar inspection technology was developed by the FRA initially as a research and development project. The technology involves high-resolution cameras mounted on an inspection vehicle. Machine vision systems monitor the images and are preprogramed to identify cracks and other defects. The technology is now commercially available and is in use on several Class I railroads.

Regulations require the use of track geometry vehicles on Class 6 track (speeds of 110 mph and higher) and also on Class 4 tracks with concrete crossties (speeds of 40 mph for freight trains and 60 mph for passenger trains). FRA regulations did not require the operation of a track geometry vehicle over the tracks where the trains derailed on May 7, 2013, near Bridgeport and July 18, 2013, in The Bronx.

The Metro-North assistant vice president–chief engineer explained at the NTSB hearing that Metro-North had not taken advantage of current automated track inspection technology, but planned to in the future. When asked about the role of such technology, he responded:

> I see it playing a tremendous role. I'm a little embarrassed to say that we did track geometry twice a year, and we really didn't use the information available to us to the benefit of Metro-North. I'm committing that's totally going to change.
>
> We're implementing immediately a quarterly track geometry implementation plan. TTCI and the TLV [Track Loading Vehicles] is part of that plan. We have an outside contractor, MERMEC, who already does it for us twice a year. They'll be part of that plan. We're going to implement GRMS; we're also looking at GRMS at least once a year.
>
> We're also looking at implementing the automated joint bar inspection that was discussed earlier. We're either going to have our contract with Sperry include that or the contract with MERMEC to implement that, and that's going to be done in the next few months.

The current MTA chairman and chief executive officer was in an acting capacity at the time of the derailment, having been recently appointed. During interviews with NTSB investigators he observed that Metro-North had not historically embraced available advanced inspection technology:

> I'm being brutally honest with you, and you guys will call it the way you see it. How can the second or largest railroad in the country not have a track geometry car when New York City Transit has four or five and Long Island's got one or two? I just don't know. And then when I ask questions, it's like, … we didn't feel we needed them, okay?

Had Metro-North adopted and fully utilized available data and automated track inspection technology, the deteriorating conditions that led to the Bridgeport and Bronx CSX derailments may have been identified.

Speed and Other Data

During the investigation of the December 1, 2013, derailment in The Bronx, NTSB investigators reviewed event recorder data from a sample of 24 trips on the Hudson Line and identified 28 events of speeds in excess of 5 mph greater than the maximum authorized speed, and two events in excess of 10 mph above the maximum authorized speed.[46] As a result of these findings, Metro-North took decertification action against the accident locomotive engineer and

[46] Each trip involved a scheduled passenger train either northbound or southbound between Grand Central Terminal and Poughkeepsie.

four other locomotive engineers.[47] Although OSA and operator fatigue were identified as causal in the December 1 accident, the engineer was speeding prior to the accident, and the apparent frequency of speeding among Metro-North engineers also raises concerns.

The speed data reviewed during the accident investigation illustrates the potential safety benefit to routinely reviewing operational data as part of risk management and a system safety program. In addition to identifying the frequency of speeding violations, the data could also have revealed that trains were too tightly scheduled (that is, they could only meet the schedule by speeding). Had Metro-North used the data to identify the issue, it could have modified the schedule, thereby removing the incentive to speed. Indeed, Metro-North acknowledged in its June 2011 100-day Action Plan that its recent speed enforcement efforts have had “concurrent impacts to [train] running times.”

Discussion

By using event recorder data as part of a formal risk management program, along with employee operational testing and training records, RTC information, equipment and track maintenance information, and accident investigation information, Metro-North could more effectively monitor and improve the safety of its operations.

During interviews with NTSB investigators, the senior vice president of operations described the Metro-North use of on-time performance as a metric:

> [W]e prided ourselves over the years for being the industry leaders in on-time performance. When I started in 1990, our on-time performance was somewhere around 90 percent. By the time we got to the mid to late ’90s, our on-time performance was around 95 percent. And most recently, up through 2012, we were 97 percent or so on all three lines. So again, we were geared towards using the on-time performance number as a metric. And the philosophy was if we can deliver trains on time, all of the supporting activity that we did, track maintenance, signal maintenance and rolling stock maintenance must be performing well if we can deliver that high degree of service reliability. So [in] my experience, there never was a clear, conscious decision, at least in the mechanical department, to give up maintenance activities for OTP [on-time performance], because if the trains weren't reliable we couldn’t achieve the 98 percent on-time performance.

However, it is clear Metro-North was unable to keep up with programmed track maintenance work, including welding rails to eliminate bolted joints, surfacing, remediating fouled ballast, and tie replacement. Deferred maintenance was evident at both the Bridgeport and the July 18, 2013, Bronx CSX derailment locations and contributed to those accidents. The deferral of track maintenance programs created more track deficiencies than track maintenance personnel could handle with the time allowed on the track and is an indication that the organization prioritized train operations over safety.

[47] Federal regulations at 49 CFR 240.305(a)(2) require that railroads revoke the certifications of locomotive engineers found to have exceeded authorized speed by 10 mph or greater.

In response to an NTSB survey, most Metro-North management personnel agreed with the statements "Metro-North management is committed to workplace safety and participates regularly in safety events" and "management does not pressure staff to maintain service or operations, potentially at a cost of safety."[48] However, most of the responding rank-and-file employees disagreed with those statements. This lack of alignment is concerning, as it shows a lack of collective commitment and shared understanding regarding safety.[49] Several employees indicated in narrative responses to the question "Is Metro-North a safe railroad?" that they believed on-time performance was given a higher priority than safety.

Primarily using on-time performance as a metric for the safety and performance of the system has limited value because deferred maintenance supports short-term performance improvement at the expense of long-term reliability and safety. As discussed above, a postaccident review of joint bar failures by NTSB investigators indicated that if Metro-North had been monitoring track repairs as part of a formal risk management program it could have identified and potentially corrected the developing problem prior to the Bridgeport accident, thereby preventing it.

NTSB concludes that Metro-North did not have an effective system for identifying, monitoring, analyzing, and mitigating safety risks. Metro-North has indicated that its newly reorganized Safety Department will be responsible for risk reduction and hazard management functions, including trend analysis. However, the NTSB notes that establishing responsibilities is only the first step. The responsibilities must be carried out consistently and effectively.

Therefore the NTSB recommends that Metro-North establish and implement a system to collect and analyze operational data to identify and mitigate adverse safety trends. The NTSB notes that, in many cases, safety issues emerge from the priority assigned to competing tasks. For example, decisions related to the priority and timing of track maintenance affect train operations and performance. Such decisions should not be made without consideration of the impact on other organizational functions, and the safety of the organization as a whole. Labor union participation is also beneficial. In the NTSB's 2014 Special Investigation Report on *Railroad and Rail Transit Roadway Worker Protection*, the NTSB highlighted the importance of union participation in accident investigations, noting that it brought operations-specific knowledge to the team and helped facilitate cooperation of employees. Including labor representatives in the review of operational and maintenance issues would provide similar benefits. Accordingly, the NTSB further recommends Metro-North require, as part of its risk management program, that representatives from all its divisions and labor organizations (1) regularly review safety and operational data from all divisions to identify safety issues and trends and (2) share the results across all divisions.

[48] For more information see Exhibit F7 from the NTSB investigative hearing.

[49] Safety culture "is something that is *shared* by (groups of) people… and "something that is mutual and reciprocal" (Guldenmund 2000) (emphasis in original). The Nuclear Regulatory Commission has defined safety culture as "the core values and behaviors resulting from a **collective commitment** by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment." (emphasis added)

Safety Reporting

In addition to monitoring known safety issues, an effective system safety program also includes mechanisms to identify new or unexpected hazards. Front line employees can be a good source of this type of hazard information. By reporting safety concerns and narrowly avoided accidents, or close calls, employees provide insight into uncontrolled risks in the system. The Metro-North Priority One safety program included an employee safety help line for employees to report safety concerns to their district safety committee for investigation. However, records provided to the NTSB indicated that during the 12 months from June 2012 to June 2013, the Metro-North safety helpline only received one call—two first aid kits required restocking.

Employees may be reluctant to report safety concerns if they are involved in the event or close call fearing discipline for their own actions. Similarly, they may fear negative consequences for reporting on the actions of others. NTSB interviews with Metro-North personnel indicated that safety reporting and fear of reprisal varied across the divisions and employee groups. For example, none of the locomotive engineers interviewed expressed any concern about reporting safety problems or their authority to halt operations in response to a safety issue. In the words of one engineer, “If you see something that’s unsafe, you’re going to stop. You’re going to call the RTC. You’re going to report it.” However, power department employees interviewed following the employee fatality in Manhattan on March 10, 2014, expressed reluctance to report their safety concerns and exercise their authority to make a good faith challenge for fear of being “blacklisted” or being the target of retaliation from foremen, supervisors, and department heads.

When asked at the NTSB’s investigative hearing what action was taken against the RTC who inadvertently removed the blocking devices in connection with the West Haven fatility, the Metro-North deputy chief of train operations stated he was removed from service and assigned 30 days of discipline, 10 days of which was re-instruction.[50] This type of response to an unintentional mistake could have a chilling effect on employee reporting. Based on this, as well as only a single report being made to the Metro-North safety hotline in 12 months and the fear of retaliation expressed by some employees, the NTSB concludes that Metro-North did not have an effective program that encouraged all employees to report safety issues and observations.

The NTSB has a history of advocating for nonpunitive safety reporting systems. In its final report on the investigation of the collision of two Washington Metropolitan Area Transit Authority (WMATA) Metrorail trains near Fort Totten Station in Washington, DC, on June 22, 2009 (NTSB 2010), the NTSB concluded:

> the safety of rail transit operations would be improved by periodic transit agency review of recorded operational data and non-punitive safety reports, which have been demonstrated to be effective tools for identifying safety problems in other modes of transportation.

[50] See Metro-North investigative hearing transcript, pages 263-264.

The NTSB recommended to WMATA:

R-10-16

> Require that your safety department; representatives of the operations, maintenance, and engineering departments; and representatives of labor organizations regularly review recorded operational data from Metrorail train onboard recorders and the Advanced Information Management system to identify safety issues and trends and share the results across all divisions of your organization.[51]

and

R-10-17

> Develop and implement a non-punitive safety reporting program to collect reports from employees in all divisions within your organization, and ensure that the safety department; representatives of the operations, maintenance, and engineering departments; and representatives of labor organizations regularly review these reports and share the results of those reviews across all divisions of your organization.[52]

For several years the FRA has been conducting pilot demonstration tests of the Confidential Close Call Reporting System (referred to as C3RS). The C3RS is a voluntary, confidential program of the FRA, the Bureau of Transportation Statistics (BTS), the DOT Volpe Center, the National Aeronautics and Space Administration, railroad carriers, carrier employees, and labor organizations. The BTS and the Volpe Center act as independent third-party managers, and a peer review team of labor, management, and FRA representatives is responsible for analyzing employee reports, implementing corrective actions, tracking results, and reporting the results to employees. Third-party management and the program agreements between labor, management, and the FRA minimize the possibility that employees will face negative consequences for reporting safety concerns. Results from the FRA demonstration sites indicate that the C3RS program has produced safety improvements. For example, data from one site indicate that run-through switches were the most frequently reported safety event, and associated derailments decreased 50 percent as a result of increased reporting following the introduction of the C3RS program. (FRA 2013)

Metro-North has announced that it is in negotiations with labor representatives and the FRA to establish a program. Metro-North told investigators that its intent is to include all employees in the C3RS program.[53] The NTSB recommends Metro-North implement a confidential close call reporting system, or similar nonpunitive safety reporting program, to encourage all employees to report safety incidents, and ensure reports are regularly reviewed as

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[51] Safety Recommendation R-10-16 is classified *Open—Acceptable Response*.
[52] Safety Recommendation R-10-17 is classified *Open—Acceptable Response*.
[53] See also Metro-North's *100-day plan* and response to FRA *Deep Dive Report*.

part of a safety risk management program with results shared across all divisions of the organization.

Oversight and Enforcement

System safety and risk management programs like data monitoring and voluntary reporting do not eliminate the need for internal and external oversight and enforcement. Direct observation and oversight are necessary to identify safety issues such as infrastructure and personnel training deficiencies, and to verify that employees are following safety policies and procedures. The March 10, 2014, roadway worker fatality in Manhattan provides an example of the importance of oversight. The NTSB and FRA investigation of this event found that Metro-North personnel failed to follow company procedures and did not conduct adequate safety briefings. Better oversight could have identified such deficient practices and reduced the likelihood of such an event. Had the accident not occurred, such violations likely would have gone uncorrected because of the noted reluctance of employees to report safety concerns.

Metro-North had a program to monitor employee compliance with rules and procedures, specifically whether a foreman properly obtained on-track protection. However, Metro-North determined inexperience was a factor in recent incidents involving on-track protection and decided to require all power department foremen to complete a new training program to update their qualification to obtain roadway worker protection. In the interim, the duties of obtaining track protection were assigned to power department supervisors. With this change in responsibilities, the power department rail supervisors were no longer recording observations of rules and procedures compliance because they would have effectively been observing themselves. Metro-North did not establish a process for the power department supervisors to be observed during this transition period. Therefore, there was no oversight to ensure the proper performance of job briefings.

Another example of inadequate oversight and enforcement was revealed in the investigation of the December 1, 2013, derailment in The Bronx. The engineer operating the train had been subject to 122 individual tests over the 12 months prior to the accident. All tests were recorded as "comply." Only one test was a field radar check on compliance with train speed. Of the 122 tests, 104 were conducted on a Tuesday. Only one was conducted on a weekend. This testing did not comply with FRA regulations or the Metro-North operational test and inspection program, which call for such tests to occur under all operating conditions.[54]

NTSB investigators interviewed a senior FRA specialist responsible for oversight of railroad operational rules testing programs on a national basis. He was provided with the operational test data on the accident engineer and observed, "with probably a couple of exceptions, the guys knew they were being observed, and it would appear to me [to be] a numbers-generating exercise."

[54] Title 49 CFR 117.9(1)(1) states that the railroad's written program of operational tests and inspections shall "provide for operational testing and inspection under the various operating conditions on the railroad," and shall state "the frequency with which each type of operational test and inspection is to be conducted." The Metro-North program specified that testing should occur on all days of the week under all operating conditions.

As noted above, during the investigation, NTSB investigators reviewed samples of Metro-North engineer compliance with train speeds using event recorder data and identified many instances where trains were being operated at excessive speeds.

Shortly after the December 1 derailment in The Bronx, Metro-North implemented an enhanced train speed monitoring program involving increased radar checks and event recorder data reviews. During the 4-year period prior to the accident, Metro-North decertified only one engineer for operating more than 10 mph over the maximum authorized speed. In contrast, during the 3-month period following the accident, Metro-North decertified five engineers (including the accident engineer) for operating more than 10 mph over the maximum authorized speed. Furthermore, during its audit of Metro-North, the FRA found that managers were not conducting banner tests on main track, only in yards. Presumably this was to avoid impacting on-time performance. This further demonstrates the need for effective oversight and enforcement.

The NTSB concludes the Metro-North program of operational testing for speed compliance was inadequate at the time of the December 1, 2013, derailment in The Bronx. The NTSB further concludes Metro-North lacked an effective oversight and enforcement program to ensure employees and managers understand and comply with established safety procedures. Therefore, the NTSB recommends Metro-North develop and implement a robust internal audit and oversight program, in coordination with its safety risk management process, to ensure that all employees and managers comply with its established safety procedures.

Auditing, Operational Testing and Safety Risk Management

Title 49 CFR Part 217 requires Metro-North and other railroads to have programs of operational tests and inspections. The Metro-North operational testing manual describes the purpose of operational oversight to include ensuring compliance with rules and reducing accident risk due to human error. The manual outlines specific tests managers should perform to confirm employees understand and adhere to operating rules. Testing is accomplished through check rides, observations, and review of data such as recorded radio traffic and event recorder downloads. The manual states that "whenever possible, tests must be conducted without the knowledge of the employees being tested." Managers who conduct tests must themselves be qualified on the operating rules:

> Supervisors who perform operational tests in accordance with this document and 49 CFR Part 217 must be qualified on the Operating Rules and/or Instructions that are being observed, as well as on the contents and procedures listed in this Manual. **The qualification of each supervisor must be documented**. (original document text is in bold)

Several Metro-North managers interviewed by NTSB investigators stated that there was no formal training program to train managers on operational testing. They indicated that training was provided by peers on the job. The NTSB investigators reviewed the training records of the five managers who performed operational testing on the accident engineer from the December 1 derailment. There was no record of any of the managers having been trained on the testing program. In addition, the training record of the manager who performed 76 percent of the operational tests on the incident engineer during the 12 months before the accident indicated that he was not trained or qualified on Metro-North operating rules.

He described his training as follows:

> A. When I got hired as an operations manager, they just—on-the-job training, with coworkers, other operations managers.
>
> Q. Okay, and as you went through the process of kind of developing your skills and doing these operations tests, did you get any kind of feedback from your managers above you on… doing okay; … need to do it different?
>
> A. No, I never got any feedback on that.

NTSB investigators noted most of the Metro-North operations and testing occurred in yards where revenue service would not be impacted or the cab where engineers would likely be aware of being observed. Random checks of event recorder data for rules compliance was not being done prior to the December 1, 2013, derailment. The FRA found the Metro-North Operations Testing Program was not compliant with regulations during its assessment after the December 1 derailment. One of the recommendations from the FRA safety assessment was to revise the program manual to bring it into compliance. Another FRA finding was:

> Many supervisors do not follow the industry standard of conducting at least one face-to-face meeting annually with each locomotive engineer and conductor to review the employee's performance, convey operational testing results, and explain Metro-North's expectations. Metro-North does not train any of its testing officers on how to conduct operational testing, does not have documentation regarding the required qualifications of each testing officer, does not provide its testing officers with a copy of its program, and fails to review its operational testing and accident data every 6 months.

A missed opportunity for reinforcing safe behavior and communication with operating employees involves the lack of face-to-face contact following test observations. During NTSB interviews, senior Metro-North managers indicated there was a general policy to make contact with tested employees who performed satisfactorily on tests and commend them. However, the line employees and line-level managers interviewed said that in their experience it was common practice only to contact employees who failed tests.

The Metro-North follow-up actions to voluntary safety audits was inadequate in some instances. APTA had previously identified related concerns with the Metro-North training of its RTCs. In both its 2007 and 2011 audits, APTA recommended that Metro-North formalize its on-the-job training of RTCs by:

> establishing checklists of all safety-critical items that are generic to the train dispatching function and expanding the effort to include such items that are specific to each shift and to each “desk” in an effort to provide a higher level of confidence of the trainee’s competencies in each of those areas.

Metro-North accepted this recommendation and the audit report reflects an action to be performed by Metro-North managers to meet the recommendation. However, in the 2011 APTA audit, the same recommendation was made because Metro-North had not completed the action. Metro-North was asked to provide the current status of actions in response to the recommendations.

The lack of follow-up actions on an audit recommendation until after a fatal accident is one of many examples of the Metro-North failure to effectively implement safety program processes. While the SSPP described internal safety audits, none were being performed and, in this instance, when an external entity developed audit recommendations, Metro-North did not follow through to ensure the recommendations were addressed.

The NTSB concludes that Metro-North managers often lacked the ability to effectively conduct audits, operational testing processes, and safety risk management actions as described in the Metro-North SSPP. Based on this finding, in combination with others in this report relating to the need for improved auditing and risk management processes, the NTSB recommends that Metro-North develop and implement a comprehensive training program for its employees on how to conduct effective internal auditing, operational testing, safety risk management analysis, and corrective action implementation.

Medical Protocols at Metro-North

The Metro-North internal medical protocol, *Medical Guidelines For Locomotive Engineers* was last updated in 1995. It states:

> Medications or treatment for chronic conditions may produce side effects that can interfere with performance of essential job functions. Therefore, the physician should evaluate the effects of medications (both acutely or on a long-term basis) on worker safety and ability to effectively perform the essential job functions above (e.g., medications whose side effects may include potential for dizziness, impaired coordination, decreased alertness, and/or loss of consciousness). Use of certain categories of [over-the-counter] and prescription drugs are prohibited for Locomotive Engineers in active service. Refer to CFR 49 for description of such

> medications.[55] Any employee or candidate currently using any of these medications may not be qualified for service.

The Metro-North medical protocol for engineers, as well as its companion protocol for conductors (last revised in 1992), make no mention of sleep disorders, their treatment, or whether individuals with a diagnosed sleep disorder would be qualified in either job. Both protocols not only ask the medical practitioner to use sound clinical judgment, but also mention a host of specific conditions including those that might worsen on exposure to the job rather than interfere with the individual's ability to perform the job. An example follows:

> Any skin impairment that upon exposure to job conditions will probably be exacerbated. Such impairments must be evaluated further. Examples of impairments that are potentially disqualifying and must be evaluated include various upper extremity dermatoses, such as chronic hand eczema or psoriasis that produce fissures, cracks, or can lead to non-localized skins infections that might be "potentially disqualifying".

Metro-North has not reviewed its medical protocols over the last two decades. The NTSB concludes the Metro-North medical protocols lacked appropriate guidance regarding sleep disorders and medications. Therefore, the NTSB recommends that Metro-North revise its medical protocols for employees in safety-sensitive positions to include specific protocols on sleep disorders, including OSA. Further, the NTSB recommends that Metro-North develop and publicize to its safety-sensitive employees a list of medications, including over-the-counter and prescription medications, that may not be used by locomotive engineers or conductors in active service.

4.3 Metropolitan Transportation Authority Organizational Factors

According to the Metro-North senior vice president of operations, most of the information historically provided to the Metro-North president and the MTA prior to these accidents referred to performance and finances. Safety information was limited to briefings on major accidents and summary data regarding employee and customer injuries.

> Typically the information that goes to the President and the Board… historically has been performance based. We report on our budgetary performance, how are we performing to budget, you know, X millions under budget; X millions over budget. If we're over budget, we identify why we're over budget and what we're doing to get within line. If we're under budget, typically there are no real questions but it's viewed as a positive; however, sometimes you could be under budget because you're not doing the work you were supposed to. So over the last year or so I've started looking in those areas where we might be significantly under budget and asking why.

[55] No such list of prohibited medications currently exists in Title 49 of the CFR.

> With regards to injuries, as has been reported previously, there used to be a safety report and a safety review done at the Board level. A number of years ago, that was stopped; however, there was still a one- or two-page report within our committee book that identified employee injury rates and customer injury rates. Most recently,…the MTA chairman, has established a safety position and we've also committed to now restarting the more detailed reports to the board on our safety performance.

During an interview with NTSB investigators, an MTA Board Member and chair of the Metro-North Committee offered the following assessment of the safety policies established by the Board and Metro-North Committee before December 1, 2013.

> I look back and really the whole safety area was a product of what DuPont made it.[56] And I can't tell you that there were many changes from the time DuPont's contract ran out, okay, up until the current time. I mean, we had–everything was running fine. You know, there was no reason to change the policies that were in effect then. But I can tell you that at no time did we ever review in detail all the policies that had been put together since DuPont. So now [what]…I'm finding to be the most, I guess, alarming is that our infrastructure is as bad as it is, because…we always thought that our infrastructure was the best. And I guess that was the way we were—that was the way it was told to us…And we never ran across anything during our committee meetings, whether it be in capital or procurements or anything that led us to believe that it was not safe, and it was not up to date, and it wasn't all we could do to protect the safety of our employees and our passengers.

Up until 2012, the MTA had a Board-level safety committee. At that time, the Board decided that safety management was better overseen directly by the operating properties and the MTA-level safety committee was replaced by individual safety committees for each property (Metro-North, LIRR, and NYCT). A Board-level safety review and safety report was also discontinued.

The NTSB identified inconsistencies among these properties that could have been identified and addressed by an MTA Board-level safety committee. For example, the MTA BRP found that the safety culture at the LIRR and the NYCT were "performing well," but not at Metro-North. Also, as noted earlier, LIRR and MTA subways owned track geometry vehicles and routinely used data in their track maintenance programs. Metro-North contracted this function and stated at the NTSB investigative hearing that they did not fully use the data generated by the contractor. Additionally, the NYCT has a lead safety officer who reports directly to the NYCT president whereas, until recently, Metro-North and the LIRR did not.

Another example of inconsistencies among MTA properties is the varied policies and procedures regarding OSA screening that were identified following the December 1, 2013,

[56] E. I. Du Pont de Nemours and Company is a chemical company that also provides safety consulting services to other industries and helped Metro-North develop the *Priority One* safety program.

derailment in The Bronx. Sleep disorders are addressed by the NYCT, but not at Metro-North or by the LIRR.

Following the collision between two Massachusetts Bay Transportation Authority green line trains in Newton, Massachusetts, on May 28, 2008, the NTSB issued Safety Recommendation R-09-09 to the FTA to develop guidance for identifying and treating individuals at risk for OSA and other sleep disorders, and also recommended in separate recommendations that all regional rail transit authorities do the following (NTSB 2009):

<u>R-09-10</u>

> Review your medical history and physical examination forms and modify them as necessary to ensure that they elicit specific information about any previous diagnosis of obstructive sleep apnea or other sleep disorders and about the presence of specific risk factors for such disorders.

<u>R-09-11</u>

> Establish a program to identify operators who are at high risk for obstructive sleep apnea or other sleep disorders and require that such operators be appropriately evaluated and treated.

The NYCT responded favorably to the recommendations and Safety Recommendation R-09-10 was classified *Closed—Acceptable Action* on September 28, 2010, and Safety Recommendation R-09-11 was classified *Closed—Acceptable Action* on April 6, 2011.

In his November 4, 2010, response to the NTSB regarding safety recommendation R-09-11, the then-president of the NYCT (now president of MTA) stated:

> Past is not prologue but it should be noted that we have never had an accident where sleep apnea was deemed to have been a contributing factor. This is due in part to our aggressive Occupational Health Services Unit and its diligence in detecting sleep disorders before they become a safety issue. Currently we are working on updating our medical standards and job profiles to strengthen our efforts in this regard. We have recently developed and implemented a program to identify Bus and Train Operators who may be at risk for sleep disorders such as sleep apnea. The program is summarized below:
>
> • All Bus and Train Operators must submit to periodic medical examinations every two years. During these exams they are asked specific questions regarding their possible history of sleep disorders/symptoms. These questions are routinely asked both electronically during the intake process and by our physician staff.
>
> • If there is an affirmative response, then in order to continue in service, those operators must provide our medical department with sleep specialist evaluations

and sleep study test results. Those who have been identified with a sleep disorder must then bring in evidence of satisfactory treatment, such as successful CPAP titration.

- These employees are then required to provide documentation of continued treatment compliance at least every three to six months.

The current NYCT medical history questionnaire includes the following among its 78 questions:

> 23. Do you have or have you ever had sleep problems?
>
> 24. Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?
>
> 25. Do you often feel tired, fatigued, or sleepy during daytime (or your scheduled shift)?
>
> 29. Do you have or have you ever had breathing problems (including those while sleeping)?"

In its response to the NTSB Safety Recommendation R-09-11, the NYCT included data indicating that the new program resulted in the NYCT identifying 64 train operators with OSA or other sleep disorders, nearly twice as many as had previously been known.

Despite the success of this safety initiative at the NYCT, the MTA did not implement the same program at its commuter rail properties—Metro-North and the LIRR—even after the FRA provided guidance on sleep disorders in its comprehensive fatigue risk reduction program (FRA 2013b). When queried by NTSB investigators about screening procedures for sleep disorders, the Metro-North chief safety officer responded:

> We do not screen for sleep apnea nor do we conduct sleep studies. We have questions on the intake form about trouble sleeping. If the answer from the employee is no, we do not follow up. If the answer is yes, then we follow up and suggest they consult with their primary care physician. We do not do sleep studies.

The employee medical history questionnaire currently used by Metro-North for railroad engineers and other safety-sensitive employees includes two questions related to sleep.[57] The first question asks about "Excessive Worry, Depression or Difficulty with Sleep" and appears to be asking about mental health and insomnia. The second question asks about "Excessive Weakness or Fatigue" rather than about snoring or daytime sleepiness. The locomotive engineer involved in the December 1, 2013, derailment in The Bronx repeatedly answered "no" to both of these questions.

[57] The Metro-North medical history questions and screening form were last updated in 1995.

The LIRR medical history questionnaire asks about any previous diagnosis of OSA. However, it does not inquire about current signs and symptoms.[58] Thus, among MTA properties, only the NYCT meaningfully screens, evaluates, and addresses treatment of OSA among its safety-sensitive employees.[59]

Based on these findings, the NTSB concludes Metro-North and the LIRR did not have adequate protocols to screen employees, especially those performing safety-sensitive functions, for sleep disorders despite the implementation of a protocol at NYCT. Therefore, the NTSB recommends that Metro-North and the LIRR develop and implement protocols to routinely screen and fully evaluate their safety-sensitive employees for sleep disorders and ensure such disorders are adequately addressed if diagnosed.

The NTSB further concludes that had the MTA implemented uniform screening protocols across all of its properties based on the success at NYCT, the Metro-North engineer's sleep disorder could have been detected and controlled prior to the December 1, 2013, derailment in The Bronx.

Based on several examples of inconsistent safety policies and practices among the MTA properties, the NTSB concludes that MTA was ineffective in sharing safety failures and successes across MTA rail properties.

The MTA has recently re-established its Board Safety committee. By conducting Board-level safety reviews, the MTA can identify other inconsistencies that would benefit from uniform treatment among all MTA properties. Therefore, the NTSB recommends that the MTA require representatives from its operating divisions to regularly review safety and operational data from all divisions to identify safety issues and trends and share the results across its operating properties. The NTSB further recommends that the MTA establish a program to systematically evaluate deficiencies identified on one MTA property and determine the applicability of safety mitigations to other MTA properties.

The NTSB also notes that findings from multiple investigations, audits, and reviews of its rail operations in response to the recent series of accidents at Metro-North (such as the FRA Deep Dive report, the TTCI review of track maintenance, and the MTA BRP) may require significant resources to address and may identify safety mitigations that are applicable to other MTA properties. Therefore, the NTSB recommends the MTA develop an oversight and tracking process to ensure that the recommendations from the various investigations and reviews of Metro-North are coordinated, assessed, and resolved at all MTA properties.

[58] The LIRR's medical history questionnaire includes only the following: "Have you ever had:16. Sleep apnea? 17. Used a CPAP machine? 18. Chronic fatigue syndrome, somnolence, insomnia, narcolepsy, any other sleep disorders or taken any medicine or treatment for sleep?"

[59] Safety-sensitive positions are defined in FRA regulations at 49 CFR 209.303.

4.4 Federal Railroad Administration Organizational Factors

4.4.1 Obstructive Sleep Apnea and Medical Fitness for Duty

A series of rail accidents investigated by the NTSB have involved OSA and other medical conditions in safety-sensitive employees. This has led to a series of safety recommendations to the FRA, several railroads, and various rail transit agencies regarding the need to adequately address OSA as well as other sleep disorders and medical conditions.

The NTSB determined the 2001 head-on collision in Clarkston, Michigan, was caused by "crewmembers' fatigue, which was primarily due to the engineer's untreated and the conductor's insufficiently treated obstructive sleep apnea." To address the fitness for duty issues raised by inadequate treatment of medical conditions, the NTSB issued Safety Recommendation R-02-24 to the FRA (NTSB 2002):

> Develop a standard medical examination form that includes questions regarding sleep problems and require that the form be used, pursuant to 49 Code of Federal Regulations Part 240, to determine the medical fitness of locomotive engineers; the form should also be available for use to determine the medical fitness of other employees in safety-sensitive positions.

In 2006, partly in response to this recommendation, the FRA created a Medical Standards Working Group within the Railroad Safety Advisory Committee (RSAC). Although the FRA has repeatedly mentioned the RSAC working group in responses to NTSB recommendations, it was disbanded after the working group was unable to reach consensus over a 5-year period. No further regulatory action has been taken by the FRA to require screening for or treatment of sleep disorders or any other medical conditions among railroad employees.

More recently, the NTSB investigated a head-on collision between two freight trains in Goodwell, Oklahoma, in June, 2012. The NTSB determined the collision was caused by the conductor's lack of engagement and the engineer's inability to see and interpret wayside signals due to a chronic illness and deteriorating eyesight (NTSB 2013). The NTSB reclassified R-02-24 *Closed—Unacceptable Action* and superseded it with Safety Recommendation R-13-21 to the FRA:

> Develop medical certification regulations for employees in safety-sensitive positions that include, at a minimum, (1) a complete medical history that includes specific screening for sleep disorders, a review of current medications, and a thorough physical examination, (2) standardization of testing protocols across the industry, and (3) centralized oversight of certification decisions for employees who fail initial testing; and consider requiring that medical examinations be performed by those with specific training and certification in evaluating medication use and health issues related to occupational safety on railroads.

The FRA responded to the NTSB that it had already created a new RSAC working group, the Fatigue Management Plans Working Group, to develop standards for railroad fatigue management plans. However, like the previous medical standards working group, the fatigue management working group has not successfully produced a proposal for revised practices. FRA officials told NTSB investigators that they hope to publish a Fatigue Risk Management Program regulation in 2015. A regulation fatigue management plan is unlikely to address fitness-for-duty issues regarding medical conditions unrelated to fatigue. On February 24, 2014, the NTSB classified the recommendation *Open—Unacceptable Response*.

In April 2011, a rear end collision occurred between a BNSF freight train and a maintenance-of-way equipment train near Red Oak, Iowa (NTSB 2012b). The NTSB determined the collision occurred due to:

> the failure of the crew of the striking train to comply with the signal indication requiring them to operate in accordance with restricted speed requirements and stop short of the standing train because the crew on the striking train had fallen asleep due to fatigue resulting from their irregular work schedules and their medical conditions.

Among other issues, the medical findings included probable sleep apnea, restless leg syndrome, and chronic insomnia. The NTSB made two medical recommendations as a result of that investigation: that the BNSF Railway medically screen employees in safety-sensitive positions for sleep apnea and other sleep disorders (R-12-26), and that the FRA require railroads to medically screen employees in safety-sensitive positions for sleep apnea and other sleep disorders (R-12-16).

The response to R-12-26 from BNSF Railroad included the following paragraph:

> Previous attempts by BNSF to require additional medical information about certain safety related medical conditions, specifically including attempts to obtain medical information on sleep apnea, met with stiff resistance from our labor organizations who alleged that these attempts to obtain medical information were in violation of various federal and state laws. Indeed, 10 unions filed charges with the Equal Employment Opportunity Commission alleging that the BNSF requirement violated the federal Americans with Disabilities Act. Those charges remain pending. Simply stated, until there are some federal standards on medical qualification for such conditions as sleep apnea, other sleep disorders or, medical conditions that affect an employee's ability to work safely, it will be difficult to obtain and use such information without facing a variety of legal challenges. BNSF believes such information may be lawfully used to improve safety without violating employee rights and is an active participant in FRA's Medical Standards Railroad Safety Advisory Council (RSAC) where this issue has been discussed.[60]

[60] Letter to NTSB, BNSF Railway Vice President, Training and Operations Support, August 23, 2012.

Essentially, BNSF told the NTSB that without related regulation, it is unable to comply with this recommendation. Safety Recommendation R-12-26 was therefore reclassified *Open—Unacceptable Response*.

As discussed above, the NTSB is concerned the FRA is not making progress promulgating regulations requiring screening for OSA and other sleep disorders. Moreover, the NTSB is equally concerned some railroads may believe they are unable to adequately address the issue without FRA regulation. Further, the NTSB believes sleep disorders are part of a larger issue that the FRA is not addressing: medical fitness for duty. The NTSB recognizes the challenges organizations face with screening employees for sleep disorders or other medical conditions despite the fact that such screening, evaluation, and treatment will reduce the risk of catastrophic accidents and potentially improve the health and well-being of employees.

The NTSB concludes that without evaluating safety-sensitive employees for sleep disorders or other medical conditions, increased risk to railroad employees, passengers, and the general public will remain, and the FRA has not adequately addressed the issue. Therefore, the NTSB recommends to the Association of American Railroads, the American Public Transportation Association, the American Short Line and Regional Railroad Association, the Brotherhood of Locomotive Engineers, and the International Association of Sheet Metal, Air, Rail and Transportation Workers collaborate to develop a model national labor agreement that supports effective programs for addressing sleep disorders and other medical conditions among safety-sensitive train operating personnel.

In response to R-12-16, the FRA Administrator wrote to the NTSB citing the Rail Safety Improvement Act of 2008 (RSIA), which requires that certain railroads develop a Risk Reduction Program (RRP).[61] Section 103(d)(2) of the RSIA (49 U.S.C. 20156) requires a railroad to include a Fatigue Management Plan in its RRP that meets the requirements of Subsection (f). 49 U.S.C. 20156(d)(2). As part of the development of Fatigue Management Plans, railroads will be required to provide opportunities for the identification, diagnosis, and treatment of any medical condition that may affect alertness or fatigue, including sleep disorders. The FRA Administrator went on to say, “Currently, FRA, in conjunction with a working group of members from the RSAC, is developing a fatigue management regulation that will be responsive to the requirements set forth in the RSIA.” The recommendation to the FRA was classified *Open—Acceptable Response* by the NTSB in October 2012. However, the RSIA specified a deadline of October 16, 2012, for this action and no action has yet been taken, nearly 2 years after the committed deadline. As a result, on November 17, 2014, NTSB reclassified Recommendation R-12-16 *Open—Unacceptable Respon*se.

The NTSB concludes that had the FRA implemented NTSB recommendations R-02-24 and R-12-16, or complied with the legislated time limit in the RSIA to require fatigue management plans by railroads, Metro-North would have been required to appropriately screen, evaluate, and treat the engineer for obstructive sleep apnea prior to the December 1, 2013,

[61] Public Law 110–432, Division A, 122 Stat. 4848-4906, enacted October 16, 2008.

derailment in The Bronx, and thus could have prevented the accident. Therefore, the NTSB reiterates R-12-16 and R-13-21.

4.4.2 Need for Redundant Track Protection

On April 10, 2008, the NTSB issued Safety Recommendation R-08-6 to the FRA. That recommendation, issued as a result of the 2007 Massachusetts Bay Transportation Authority accident that killed two track workers at Woburn, Massachusetts, asked the FRA to: "Require redundant signal protection, such as shunting, for maintenance-of-way work crews who depend on the train dispatcher to provide signal protection." (NTSB 2008)

In its September 2008 response to R-08-06, the FRA stated that it would include the issue of alternate means of redundant protection in its upcoming NPRM on roadway worker protection and seek industry comment. However, at the time of the May 2013 West Haven employee fatality, the FRA still had not added a requirement for redundant signal protection. That accident was caused by the Metro-North RTC's erroneous removal of signal blocking protection for the track segment occupied by the track foreman. The accident might have been avoided if redundant signal protection had been in place.

It has been more than 6 years since the NTSB recommended the FRA require redundant signal protection for roadway workers who depend on train dispatchers and RTCs to provide signal protection. Accordingly, R-08-06 is reclassified from O*pen*—*Acceptable Response* to *Open—Unacceptable Respons*e.

4.4.3 System Safety Program Rulemaking

On September 7, 2012, the FRA published an NPRM to require commuter and intercity passenger railroads to develop and implement a system safety program (*Federal Register* 2012, 55372). The FRA proposed the system safety program regulation to satisfy a statutory mandate in the RSIA to require certain railroads to implement safety risk reduction programs.[62] The NPRM describes the proposed system safety program as "a structured program with proactive processes and procedures developed and implemented by commuter and intercity passenger railroads to identify and mitigate or eliminate hazards and the resulting risks on each railroad's system." The proposed regulation would require railroads to submit a written SSPP to the FRA for review and approval.

According to the NPRM, the procedures, processes, and programs that would be covered by the system safety program include maintenance, inspection, and repair; rules compliance and procedures review; employee/contractor training; and public safety outreach. The NPRM further states that: "Since most of these are procedures, processes, and programs railroads should already have in place, the railroads would most likely only have to identify and describe such procedures, processes, and programs to comply with the regulation."

[62] Public Law 110-432, Division A, 122 Stat. 4848, codified at 49 United States Code 20156, and 20118-20119.

As previously discussed, Metro-North has for many years had an SSPP that presumably will fulfill the proposed regulatory requirement for such a program. However, while the NTSB investigations found Metro-North had a written SSPP, its implementation was very limited and represented little more than a paperwork exercise. Few Metro-North employees even knew the program existed. The identified deficiencies in the Metro-North SSPP implementation provide a cautionary example to FRA as it finalizes the proposed regulation.

The NTSB has long advocated the use of safety management systems (SMS) in all modes of transportation. Many NTSB accident investigations have produced findings that an effective SMS or system safety program could have prevented the loss of life and injuries. Through the implementation of an effective SMS, operations are continually monitored and pertinent data collected to identify emerging and address developing safety problems before they result in death, injury, or significant property damage. An SMS combines established system safety engineering principles with advanced organizational management techniques, and supports continuous improvement in safety performance through a positive safety culture founded on four key priorities: safety policy, safety risk management, safety assurance, and safety promotion.

The NTSB addressed the value of SMS for railroads in the final report on the 2009 derailment of a Canadian National Railway Company (CN) freight train in Cherry Valley, Illinois (NTSB 2012c). The NTSB concluded that had an effective SMS been implemented at the CN, the inadequacies and risks that led to the accident would have been identified and corrected and, as a result, the accident may have been prevented. Accordingly, on March 2, 2012, the NTSB recommended that the FRA:

<u>R-12-3</u>

> Require that safety management systems and the associated key principles (including top-down ownership and policies, analysis of operational incidents and accidents, hazard identification and risk management, prevention and mitigation programs, and continuous evaluation and improvement programs) be incorporated into railroads' risk reduction programs required by Public Law 110-432, Rail Safety Improvement Act of 2008, enacted October 16, 2008.

In its May 15, 2012, response letter, the FRA equated its system safety program NPRM with SMS. The FRA also noted in the NPRM that safety management systems, such as those addressed in the Federal Aviation Administration NPRM on this subject, are "similar to the" system safety program. The letter stated that the NPRM would require passenger railroads to implement system safety programs, "that systematically evaluate railroad safety hazards on their systems; and manage those risks in order to reduce the numbers and rates of railroad accidents, incidents, injuries, and fatalities." The letter further stated that "[t]he required components of the [system safety programs] will include top-down ownership and policies, analysis of operational incidents and accidents, hazard identification and risk management, prevention and mitigation programs, and continuous evaluation and improvement programs." On July 18, 2012, Safety

Recommendation R-12-3 was classified *Open—Acceptable Response* pending publication of the final rule.

On August 26, 2014, the NTSB reiterated Safety Recommendation R-12-3 in response to its investigation of the Conrail Freight Train Derailment with Vinyl Chloride Release in Paulsboro, New Jersey, on November 30, 2012 (NTSB 2014b). In its letter to the FRA, the NTSB discussed the required elements of an effective system safety program. In reference to guidance from the International Civil Aviation Organization, the NTSB noted that a properly implemented SMS approach would have required more thorough evaluation of the decision to continue operation of the bridge that malfunctioned in that accident, and could have more clearly identified the deficiencies and risks that would have likely lead to operational changes prior to the accident.

The NTSB believes it is important for the FRA to provide strong leadership for railroads and for its inspectors as the system safety program is rolled out. A management systems approach will require cultural change at the FRA as well as in the industry. In its final report on the crude oil train derailment at Lac-Megantic, Quebec, the Transportation Safety Board of Canada (Transportation Safety Board of Canada 2014) expressed concerns about the Transport Canada SMS regulation that could be instructive here:

> Because regional railways were the responsibility of each TC [Transport Canada] Region, TC Headquarters did not provide leadership, but rather limited its role to providing support for regional oversight of the SMS program. The support focused on helping Regions prepare and deliver audits of regional railways. TC Headquarters did not provide the minimum requirements regarding audit frequency or audit scope to the Regions. Moreover, TC Headquarters did not monitor regional auditing activities to ensure that the minimum standards were being met and that all activities, such as following up on audit findings, were consistently performed. Consequently, TC Headquarters was unaware of any weaknesses in oversight of regional railways in Quebec, and did not intervene to provide additional support. Without sufficient national monitoring, TC does not have adequate assurance that its Regions are providing effective oversight of regional railways to ensure that the risks to the public are being properly managed.

The NTSB notes that the FRA-proposed system safety program regulation represents a departure from the historic approach used by the FRA for oversight and safety management. For example, rather the monitoring rules compliance, a system safety approach seeks to further improve safety through identification and control of potential safety hazards that may not technically violate prescriptive FRA regulations. During the NTSB hearing, the regional administrator for the FRA region that includes the Metro-North explained that FRA inspectors have no authority to enforce a railroad’s standards beyond the FRA regulatory standards:

> Q: Does FRA have the authority to hold a railroad to its higher maintenance standards like their own track safety standards? Can you enforce those?
>
> A: No, we cannot. We can enforce the FRA standards but if a railroad has stricter standards, we cannot enforce those.
>
> In 2000, Emeritus Professor Andrew Hopkins noted that:
>
> Safety management systems can degenerate into nothing more than complex systems of paper. But they can be prodded into life by vigorous action by regulators, insisting on active employee participation and carrying out searching audits of elements of the system (Hopkins 2000).

Transitioning to a system safety program regulation will be new territory for the FRA. As noted in the regional administrator's comments above, FRA has traditionally had clear minimum safety standards and limited ability to examine the effectiveness of railroad management systems for hazard identification and management. The NTSB concludes that a robust method to assess the effectiveness of the FRA's proposed requirements for system safety programs will be critical to identifying and addressing deficiencies. Therefore, the NTSB recommends that when the proposed system safety program regulation is promulgated, the FRA develop and implement a robust performance-based audit program to ensure that railroads are maintaining effective system safety programs.

4.4.4 FRA National Inspection Plan

In response to a 2004 memorandum from the Department of Transportation, Office of the Inspector General (OIG), the FRA established a National Inspection Plan (NIP) in 2005. The OIG recommended the FRA target its inspection and enforcement efforts to address safety problems that are most likely to result in accidents and injuries through systemic use of trend analysis, along with other data analysis tools, to examine key indicators of a railroad's safety condition (e.g., its accident rate, defect ratio, and employee injury statistics). Previously, the FRA had a less structured, less consistent, and less data-driven approach for planning inspections. According to agency officials, each region prepared its own inspection plan based on judgments about appropriate priorities and analysis of available data. However, the use of data was not consistent from region to region. Inspectors had greater discretion about where to inspect and based decisions about priorities on their knowledge of their inspection territories. The OIG recommendation called for focused field inspection activities, assessment of effective partnerships contrasted against more traditional enforcement efforts, factoring prior safety/enforcement history when determining fines, and including specific milestones for measuring progress.

The FRA NIP is intended to reduce accidents by providing guidance to each regional office on how inspectors in each of the five FRA disciplines of Track, Operating Practices, Motive Power and Equipment, Signal and Train Control, and Hazardous Materials should divide their work by railroad and state. The FRA uses data models to focus inspection efforts in places deemed likely to have safety problems. The key data inputs are train accidents, employee injuries, grade crossing accidents, and inspection results. The outputs are by inspection discipline with a suggested percentage goal of inspection hours to be devoted to a particular railroad. Regional administrators may adjust these goals for their respective regions based on local knowledge and emerging issues to allow regions to respond to new and unexpected events such as major accidents. The FRA monitors on an annual basis how the regions are meeting their inspection goals, and requires the regions to submit reports on any missed NIP goal.

As with the proposed system safety program regulation, the NIP represents a significant departure from the FRA's historic compliance-based oversight, to a risk-based approach. A 2013 report by the Government Accountability Office (GAO) on the FRA described this move to a risk-based approach to be "a significant procedural and cultural change for FRA and the railroad industry." The FRA officials are aware of the challenges to allocating oversight resources when moving to a risk-based approach (GAO 2013). During interviews with NTSB investigators, the FRA Associate Administrator for Railroad Safety and Chief Safety Officer stated:

> [W]e do want our work to be data driven and risk based, and, … we head [in] that direction in some areas. For example, … we have quiet zone rules that look at risk specifically. Our PTC rules don't look at risk, but they look at risk overall as they make improvements to signal systems. Our risk reduction programs, … have their eye on risk. So we're starting to develop it, but … risk is not, not something that our core inspectors are real familiar with. That's not been their job. That's not been their role.

Based on the experiences of other transportation agencies implementing risk management approaches, GAO suggests the FRA implementation of a risk management approach will:

> increase the agency's workload and require the addition of a new safety discipline, as the task of reviewing and approving the plans is significantly different than conducting safety inspections in the five traditional disciplines. (GAO 2013)

The NTSB agrees that the FRA's move toward a risk management function will require time and resources to become fully effective. The use of safety and performance data to focus inspection resources is fundamentally a reasonable approach to mitigate risk. The NTSB investigators examined accident and incident data available from FRA Office of Safety Analysis to understand the efficacy of the NIP since its inception. Data from 2005 through 2013 for all commuter railroads and Amtrak indicate there has been an increase in accident and incidents. (see figure 28.) The NTSB concludes that, although data from 2005 through 2013 for all commuter railroads and Amtrak indicating there has been an increase in accidents and incidents is not a full measure of the effectiveness of the NIP, it does indicate that current methodology may not be effective in identifying systemic safety issues.

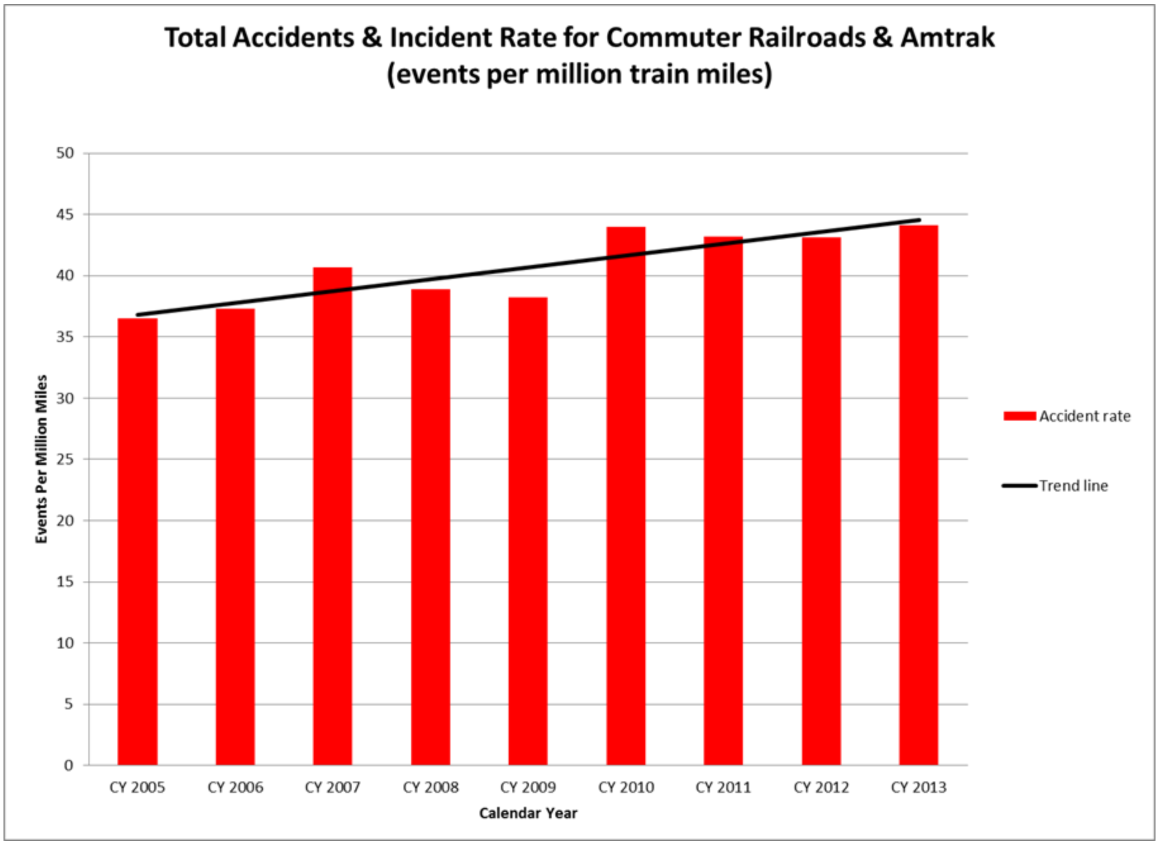

Figure 28. Annual number of accidents and incidents for commuter railroads and Amtrak reported to the FRA.

The NTSB investigations of the five Metro-North accidents identify issues that FRA should address in its NIP. As noted above, the NIP uses accident/incident investigation data to allocate inspection resources. Prior to 2013, Metro-North had a very good accident and employee injury safety record. However, the NTSB investigations and the FRA Deep Dive Report found numerous systemic safety deficiencies at Metro-North.

When asked to provide the actual number of hi-rail or walking inspections by FRA inspectors on the New Haven line, Subdivision 7, from January 1, 2012, to the date of the Bridgeport derailment, the FRA responded:

> A review of the FRA track inspection records did not show a hi-rail or walking inspection by a FRA inspector on the New Haven Line through the accident site at near Milepost 53.3 between January 1, 2012 and May 17, 2013, the accident date. The previous hi-rail or walking inspection was conducted in October and November, 2011.
>
> However, the data did show that FRA conducted multiple inspection activities on the Metro-North during the time period indicated. The data did show that the region was on target with their National Inspection Plan (NIP).

The FRA response went on to explain that the track inspector position responsible for Metro-North inspections was vacant for 1 year during this period, but has since been filled.

Investigators also reviewed FRA inspection reports for Metro-North involving the roadway protection program, including proper employee briefings. The FRA records from 2012 indicate 87 inspections.[63] Ten defects were noted during the year and included the failure of a train to provide audible warning, improper control of entry (into work area), and an individual's failure to follow the protection rules.

FRA records from 2013 indicated 202 inspections. Only nine inspections were performed on weekends. By August 2013, Metro-North Railroad had experienced three accidents (Bridgeport on May 17, 2013, West Haven on May 28, 2013, and The Bronx on July 18, 2013) and the FRA had increased its inspections. From January 2013 to June 2013, the FRA conducted 50 inspections; from July to December it conducted 152 inspections. Eight defects were noted in 2013, including three failures to have proper documents, failure to comply with an on-track safety rule, failure of an employee to obtain authority before fouling the track, failure to provide timely warning to workers, failure not to overlap foul times, and an unauthorized movement into the working limits.

Starting in December 2013 and for next 3 months, the FRA conducted a more focused inspection of Metro-North. In the first 2 months of 2014, including 9 days of March 2014, the FRA records included 143 inspections. Only 11 inspections were performed on weekends. In January 2014, FRA inspectors performed 93 inspections and in February 2014 they conducted 48 inspections. Five railway worker protection defects were noted. Three defects were recorded for improper on-track safety documents, one defect for a train's failure to provide an audible warning, and one defect for the failure of an employee to provide a job briefing.

During the Metro-North track worker and electrician interviews, they were asked if they had seen or been approached by a representative of the FRA while they were on duty since they started working at Metro-North. None of the individuals had encountered an FRA inspector during their career on the railroad. Thus, it is apparent that the FRA Metro-North inspection program ramped up only after several significant Metro-North accidents.

On September 24, 2014, the NTSB issued a Special Investigation Report, *Railroad and Transit Roadway Worker Protection*. (NTSB 2014) The special investigation evaluated 15 fatal-injury accidents involving roadway workers that occurred during 2013. In the report, the NTSB noted that some of the fatalities involved insufficient oversight by the FRA, particularly related to the adequacy of job briefings. The NTSB concluded "that given the high number of fatalities in 2013, the lower number of defects and violations relating to job briefings may represent a decline in the effectiveness of FRA inspections." As a result, the NTSB recommended that the FRA:

[63] The numbers shown only apply to railway worker protection inspections. Each inspection report may show multiple "units," meaning that the inspector noted multiple observations during that inspection. For simplicity sake, only the total inspections are given in this report.

R-14-34

> Revise your national inspection program to include specific emphasis on roadway worker activities, including emphasizing hazard recognition and mitigation in job briefings.

The West Haven accident was one of the accidents evaluated as part of the roadway worker special investigation, but the Manhattan accident, which also involved inadequate job briefings, occurred after the evaluation period. Accordingly, based on the Manhattan accident, the NTSB reiterates Safety Recommendation R-14-34.

The FRA did not conduct any visual or track geometry car inspections for the years 2012 and 2013 on Metro-North prior to the Bridgeport derailment. The FRA track inspections are designed to see if the railroad's track inspectors are reporting the track conditions that exist and to gather data and assess track conditions. An enforcement presence by the FRA helps to keep railroad track inspections and track maintenance not only in compliance with the FRA regulatory standards, but also highlights other underlying problems.

Metro-North is the second largest commuter railroad and one of the busiest in the United States. The NTSB is concerned that regulatory inspections on Metro-North were not given a higher priority by the FRA, considering the potential for accidents involving catastrophic consequences. The NTSB concludes that the FRA system for prioritizing enforcement efforts was ineffective and resulted in a lower FRA presence on Metro-North at the same time that track conditions were deteriorating, thereby increasing the risk of a catastrophic accident.

Annual ridership on Metro-North is nearly 83 million passengers. Despite the low accident history, the safety deficiencies at Metro-North represented increasing risks that were not being adequately addressed. Therefore, the NTSB concludes that the FRA approach to allocating inspection resources does not adequately consider potential consequences when evaluating overall risk. Therefore, the NTSB recommends that the FRA review and revise its NIP procedures to ensure that sufficient inspection resources are being allocated to railroads having the greatest potential risk for high-consequence accidents.

4.5 Medical Community and Sleep Disorders

The medical profession continues to evolve its understanding of sleep disorders and their association with other health conditions. In 1988, the Congress created the National Commission on Sleep Disorders Research to conduct a comprehensive study of the status of then-current knowledge and research on sleep disorders. The Commission delivered its report, titled, *Wake Up America: A National Sleep Alert* to the Congress in January, 1993. In its report, the Commission identified sleep problems as a public health crisis and recommended a number of countermeasures. In particular, it documented that primary care physicians lacked adequate training regarding the prevalence and risk factors for sleep disorders. The Commission estimated that 95 percent of patients with sleep disorders were undiagnosed. Subsequently, the National Center for Sleep Disorders Research was created within the National Heart, Lung, and

Blood Institute at the National Institutes of Health and tasked with conducting and supporting research, training scientists, disseminating information, and other activities on sleep disorders and related concerns.

In the United States, primary care physicians for adults are generally trained (and usually Board certified) in family practice or internal medicine. Following initial residency training, all states require continuing medical education to maintain licensure and the certifying boards for both specialties require proof of ongoing education and periodic formal re-examination. However, a 2011 study found the majority of primary care physicians do not ask their patients who report fatigue or other related symptoms any questions about sleep patterns or snoring, and do not seem to consider a diagnosis of OSA or other sleep disorders (Mold and others 2011).

Although the current prevalence of OSA in the United States adult population is estimated between 10 and 25 percent, a recent study suggested a third of adult patients who underwent routine exams were identified as having a high risk for OSA, including 14-17 percent who reported having fallen asleep while driving, yet were not diagnosed as having OSA (Hiestand and others 2006) (Grover and others 2011). This suggests many primary care providers do not have adequate training to identify OSA risk factors and ask the right questions to effectively screen patients for OSA.

The NTSB concludes that in many instances primary care providers do not adequately evaluate their patients for OSA, as occurred with the engineer involved in the December 1, 2013, derailment, and insufficient health care provider training on the topic is the most likely cause. Therefore, the NTSB recommends the American College of Physicians enhance initial and ongoing training to ensure that Board-certified physicians in Internal Medicine can successfully identify risk factors for, evaluate, and effectively treat OSA among their patients.

The NTSB also recommends to the American Academy of Family Physicians enhance initial and ongoing training to ensure that Board-certified physicians in Family Medicine can successfully identify risk factors for, evaluate, and effectively treat OSA among their patients.

5 Conclusions

5.1 Findings

1 Metro-North Railroad did not effectively use its System Safety Program Plan or Priority One Program for their intended purposes of providing guidance for managing the safety of the Metro-North Railroad operations and employees.

2 The Metro-North Railroad Safety and Security Department was ineffective in identifying and resolving operational or process safety issues across its departments, and the organizational structure of Metro-North Railroad and its safety programs did not support effective safety risk management of all its departments and functions.

3 Metro-North Railroad did not effectively investigate accidents and incidents and address known deficiencies to continuously improve and revise processes to prevent recurrences.

4 Metro-North Railroad did not have an effective system for identifying, monitoring, analyzing, and mitigating safety risks.

5 Metro-North Railroad did not have an effective program that encouraged all employees to report safety issues and observations.

6 The Metro-North Railroad program of operational testing for speed compliance was inadequate at the time of the December 1, 2013, derailment in The Bronx.

7 Metro-North Railroad lacked an effective oversight and enforcement program to ensure that employees and managers understand and comply with established safety procedures.

8 Metro-North Railroad managers often lacked the ability to effectively conduct audits, operational testing processes, and safety risk management actions as described in the Metro-North Railroad System Safety Program Plan.

9 Metro-North Railroad medical protocols lacked appropriate guidance regarding sleep disorders and medications.

10 Metro-North Railroad and the Long Island Railroad did not have adequate protocols to screen employees, especially those performing safety-sensitive functions, for sleep disorders despite the implementation of a protocol at New York City Transit.

11 Had the Metropolitan Transportation Authority implemented uniform screening protocols across all of its properties based on the success at New York City Transit, the Metro-North Railroad engineer's sleep disorder could have been detected and controlled prior to the December 1, 2013, derailment in The Bronx.

12 Metropolitan Transportation Authority was ineffective in sharing safety failures and successes across Metropolitan Transportation Authority rail properties.

13 Without evaluating safety-sensitive employees for sleep disorders or other medical conditions, increased risk to employees, passengers, and the general public will remain, and the Federal Railroad Administration has not adequately addressed the issue.

14 Had the Federal Railroad Administration implemented National Transportation Safety Board recommendations R-02-24 and R-12-16, or complied with the legislated time limit in the Rail Safety Improvement Act of 2008 to require fatigue management plans by railroads, Metro-North Railroad would have been required to appropriately screen, evaluate, and treat the engineer for obstructive sleep apnea prior to the December 1, 2013, derailment in The Bronx, and thus could have prevented the accident.

15 A robust method to assess the effectiveness of the Federal Railroad Administration's proposed requirements for system safety programs will be critical to identifying and addressing deficiencies.

16 Although data from 2005 through 2013 for all commuter railroads and Amtrak indicating there has been an increase in accidents and incidents is not a full measure of the effectiveness of the National Inspection Plan, it does indicate that current methodology may not be effective in identifying systemic safety issues.

17 The Federal Railroad Administration system for prioritizing enforcement efforts was ineffective and resulted in a lower Federal Railroad Administration presence on Metro-North Railroad at the same time that track conditions were deteriorating, thereby increasing the risk of a catastrophic accident.

18 The Federal Railroad Administration approach to allocating inspection resources does not adequately consider potential consequences when evaluating overall risk.

19 In many instances, primary care providers do not adequately evaluate their patients for obstructive sleep apnea, as occurred in the case of the engineer in the December 1, 2013, derailment, and insufficient health care provider training on the topic is the most likely cause.

6 Recommendations

6.1 New Recommendations

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

To Metro-North Railroad:

Establish and implement a system to collect and analyze operational data to identify and mitigate adverse safety trends. (R-14-57)

Require, as part of your risk management program, that representatives from all your divisions and labor organizations (1) regularly review safety and operational data from all divisions to identify safety issues and trends and (2) share the results across divisions. (R-14-58)

Implement a confidential close call reporting system, or similar nonpunitive safety reporting program, to encourage all employees to report safety incidents, and ensure reports are regularly reviewed as part of a safety risk management program with the results shared across all divisions of the organization. (R-14-59)

Develop and implement a robust internal audit and oversight program, in coordination with your safety risk management process, to ensure that all employees and managers comply with your established safety procedures. (R-14-60)

Develop and implement a comprehensive training program for your employees on how to conduct effective internal auditing, operational testing, safety risk management analysis, and corrective action implementation. (R-14-61)

Revise your medical protocols for employees in safety-sensitive positions to include specific protocols on sleep disorders, including obstructive sleep apnea. (R-14-62)

Develop and publicize to your safety-sensitive employees a list of medications, including over-the-counter and prescription medications, that may not be used by locomotive engineers or conductors in active service. (R-14-63)

Develop and implement protocols to routinely screen and fully evaluate your safety-sensitive employees for sleep disorders and ensure that such disorders are adequately addressed if diagnosed. (R-14-64)

To the Long Island Railroad:

> Develop and implement protocols to routinely screen and fully evaluate your safety-sensitive employees for sleep disorders and ensure that such disorders are adequately addressed, if diagnosed. (R-14-65)

To the Metropolitan Transportation Authority:

> Require representatives from your operating divisions to regularly review safety and operational data from all divisions to identify safety issues and trends and share the results across your operating properties. (R-14-66)

> Establish a program to systematically evaluate deficiencies identified on one Metropolitan Transportation Authority property, and determine the applicability of safety mitigations to other Metropolitan Transportation Authority properties. (R-14-67)

> Develop an oversight and tracking process to ensure that the recommendations from the various investigations and reviews of Metro-North Railroad are coordinated, addressed, and resolved at all Metropolitan Transportation Authority properties. (R-14-68)

To the Federal Railroad Administration:

> When the proposed system safety program regulation is promulgated, develop and implement a robust performance-based audit program to ensure that railroads are maintaining effective system safety programs. (R-14-69)

> Review and revise your National Inspection Plan procedures to ensure that sufficient inspection resources are being allocated to railroads having the greatest potential risk for high-consequence accidents. (R-14-70)

To the Association of American Railroads, the American Public Transportation Association, the American Short Line and Regional Railroad Association, the Brotherhood of Locomotive Engineers, and the International Association of Sheet Metal, Air, Rail and Transportation Workers:

> Collaborate to develop a model national labor agreement that supports effective programs for addressing sleep disorders and other medical conditions among safety-sensitive train operating personnel. (R-14-71)

To the American College of Physicians:

> Enhance initial and ongoing training to ensure that Board-certified physicians in Internal Medicine can successfully identify the risk factors for, evaluate, and effectively treat obstructive sleep apnea among their patients. (R-14-72)

To the American Academy of Family Physicians:

Enhance initial and ongoing training to ensure that Board-certified physicians in Family Medicine can successfully identify risk factors for, evaluate, and effectively treat obstructive sleep apnea among their patients. (R-14-73)

6.2 Previously Issued Recommendations

As a result of these accident investigations, the National Transportation Safety Board previously issued the following recommendations:

To the Federal Railroad Administration:

As a result of the Bridgeport, Connecticut, accident:

Revise the Track Safety Standards specified in Title 49 *Code of Federal Regulations* 213.233(b)(3), removing the exemption for high-density commuter railroads and requiring all railroads to comply with these requirements: (1) to traverse each main track by vehicle or inspect each main track on foot at least once every 2 weeks, and (2) to traverse and inspect each siding, either by vehicle or on foot, at least once every month. (R-14-11) (*Open—Await Response*)

To the Metro-North Railroad:

As a result of the employee fatality in West Haven, Connecticut:

Immediately implement redundant signal protection, such as shunting, for maintenance-of-way work crews who depend on the train dispatcher to provide signal protection. (R-13-17) (Urgent) (*Closed—Acceptable Action*)

As a result of the December 1, 2013, derailment in The Bronx, New York:

Survey your system and install approach permanent speed restriction signs where permanent changes in train speed apply, to alert train operating crews of the reduced speeds. (R-14-07) (*Open—Acceptable Response*)

Require the installation, in all controlling locomotive cabs and cab car operating compartments of crash- and fire-protected inward- and outward-facing audio and image recorders capable of providing recordings to verify that train crew actions are in accordance with rules and procedures that are essential to safety as well as train operating conditions. The devices should have a minimum 12-hour continuous recording capability with recordings that are easily accessible for review, with appropriate limitations on public release, for the investigation of accidents or for use by management in carrying out efficiency testing and systemwide performance monitoring programs. (R-14-08) (*Open—Acceptable Response*)

Regularly review and use in-cab audio and image recordings in conjunction with other performance data, to verify that train crew actions are in accordance with rules and procedures that are essential to safety. (R-14-09) (*Open—Acceptable Response*)

As a result of the Bridgeport, Connecticut, accident:

Revise your track inspection program to include requirements (1) to traverse each main track by vehicle or inspect each main track on foot at least once every 2 weeks, and (2) to traverse and inspect each siding, either by vehicle or on foot, at least once every month. (R-14-12) (Open—Acceptable Action)

6.3 Previously Issued Recommendations Classified in This Report

Safety Recommendation R-14-07 to the Metro-North Railroad is reclassified *Open—Acceptable Response* in section 3.4.1 of this report.

Survey your system and install approach permanent speed restriction signs where permanent changes in train speed apply, to alert train operating crews of the reduced speeds. (R-14-07)

Safety Recommendation R-08-06 to the Federal Railroad Administration is reclassified *Open—Unacceptable Response* in section 4.4.2 of this report.

Require redundant signal protection, such as shunting, for maintenance-of-way work crews who depend on the train dispatcher to provide signal protection. (R-08-06)

Safety Recommendation R-14-12 to Metro-North Railroad is reclassified *Open—Acceptable Action* in section 3.1.3 of this report.

Revise your track inspection program to include requirements (1) to traverse each main track by vehicle or inspect each main track on foot at least once every 2 weeks, and (2) to traverse and inspect each siding, either by vehicle or on foot, at least once every month. (R-14-12)

6.4 Previously Issued Recommendations Reiterated in This Report

Safety Recommendations R-12-16, R-13-21, and R-14-34 to the Federal Railroad Administration are reiterated in section 4.4.1 of this report.

Require railroads to medically screen employees in safety-sensitive positions for sleep apnea and other sleep disorders. (R-12-16)

Develop medical certification regulations for employees in safety-sensitive positions that include, at a minimum, (1) a complete medical history that includes specific screening for sleep disorders, a review of current medications, and a thorough physical examination, (2) standardization of testing protocols across the industry, and (3) centralized oversight of certification decisions for employees who fail initial testing; and consider requiring that medical examinations be performed by those with specific training and certification in evaluating medication use and health issues related to occupational safety on railroads. (R-13-21)

Safety Recommendation R-14-34 is reiterated in section 4.4.4 of this report:

Revise your national inspection program to include specific emphasis on roadway worker activities, including emphasizing hazard recognition and mitigation in job briefings. (R-14-34)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

CHRISTOPHER A. HART
Acting Chairman

ROBERT L. SUMWALT
Member

MARK R. ROSEKIND
Member

EARL F. WEENER
Member

Adopted: November 19, 2014

Member Sumwalt filed the following statement.

Board Member Statements

Board Member Robert L. Sumwalt filed the following concurring statement on November 19, 2014.

Between May 17, 2013, and March 10, 2014, Metro-North experienced five accidents that were investigated by the NTSB. The appendices of this special investigation report (SIR) contain the narratives for each of these unfortunate events, which collectively resulted in 6 lives lost, 126 injuries, and more than $28 million in property damages.

I repeatedly asked myself how an organization could put itself into the unfortunate position of compromising safety to such a degree. As with most transportation disasters, there is no simple answer. However, one thing became abundantly clear in my review of the accidents and their public dockets: there seemed to be an obsession at Metro-North with on-time performance—so much so that Metro-North management came to believe that on-time performance could be an effective metric of the health of the system. According to an NTSB interview with Metro-North's senior vice president of operations, "We were geared towards using the on-time performance numbers as a metric. The philosophy was that if we can deliver trains on time, all of the supporting activity that we did, track maintenance, signal maintenance, and rolling stock maintenance must be performing well if we can deliver that high degree of service reliability."

To use on-time performance as a metric of system health is a flawed assumption, because it overlooks the age-old conflict between production and safety.[1] If the scale is tipped too far in favor of production, catastrophe can occur; if the scale is tipped too far in the other direction, production is sacrificed. Unfortunately, at Metro-North, it appears the scale was heavily tipped to favor on-time performance in lieu of safety.

Several employee comments during the NTSB's investigations shone light on Metro-North's obsession with on-time performance. For example, an NTSB-conducted survey yielded comments such as: "Metro-North pays lip service to safety. On time performance and budgets take precedence over safety." Another employee stated: "The railroad only cares about the on-time performance." One employee commented: "It's all about on-time performance and safety rules are thrown out the window to keep on-time performance." All told, one out of every seven surveyed employees—including management as well as rank-and-file employees—expressed concerns about an overemphasis on on-time performance.

As this SIR notes, one indicator that the organization prioritized train operations over safety was the deferral of track maintenance programs. This, according to the report, created more track deficiencies than track maintenance personnel could handle within the time allotted

[1] For example, see: Reason, J. (1997). *Managing the Risks of Organizational Accidents.* Aldershot, England: Ashgate; Maurino, D., Reason, J., Johnston, N. & Lee, R. (1995). *Beyond Aviation Human Factors*. Aldershot, England: Avebury.

on the track. Another red flag was the number of train speed violations found by NTSB investigators—an indication that trains were too tightly scheduled.

The MTA's Blue Ribbon Panel report applauded Metro-North's president's recent decision to reduce on-time performance pressures within the organization by lowering on-time performance goals from 97 percent to 93 percent.[2] "This action was an important signal to the workforce. The railroad will not seek to achieve its former high on-time performance numbers until there is a high degree of confidence that safe operations and safe practices are of paramount importance."

Unfortunately, in spite of attempts to take some of the pressure off of the system by reducing on-time performance expectations, others are applying political pressure to do otherwise. On November 17, 2014, the Governor of Connecticut issued a press release to chide Metro-North's lack of on-time performance: "Our commuters have a right to expect a culture of safety and on-time performance levels of 95 percent or better." That same day, Connecticut's DOT commissioner wrote a scathing letter to the Metro-North president, also criticizing Metro-North's lack of timely operations:

> We have added service to increase the frequency and convenience of the New Haven Line. Yet, Metro-North's service quality is unacceptable…. With the exception of September 2014, trains have been running well below even your own target of 92 percent, and often well below 90 percent. Yet, I have seen no campaign to identify and attack the causes of this performance. I am asking you to perform an assessment of every class of service delay for failed train performance and an action plan to bring on-time performance to a minimum of 95 percent. Please deliver this analysis and plan to me by December 1, 2014.

His requested date is stingingly ironic: December 1 will be the one-year anniversary of a deadly Metro-North derailment in the Bronx which claimed four lives and injured several others. How quickly we forget safety concerns when on-time performance is so high on the agenda.

The accident record of Metro-North clearly points out that improvement needs to be made, and the information in this SIR should serve as a blueprint for areas in need of attention. During the necessary rebuilding of Metro-North's safety and operations, however, on-time performance should be the least of anyone's concerns.

[2] Metropolitan Transportation Authority. (2014). *Blue Ribbon Panel Final Report*, August 27, 2014.

7 Appendices

7.1 Appendix A – Brief of Derailment in Bridgeport (May 17, 2013)

National Transportation Safety Board

Railroad Accident Brief

Derailment and Subsequent Collision of Two Metro-North Passenger Trains

Accident No.:	DCA13MR003
Location:	Bridgeport, Connecticut
Date:	May 17, 2013
Time:	6:01 p.m. eastern daylight time
Railroad:	Metro-North Railroad
Property damage:	$18.5 million
Injuries:	65
Fatalities:	0
Type of accident:	Collision

The Accident

On Friday, May 17, 2013, at 6:01 p.m. eastern daylight time, eastbound Metro-North Railroad (Metro-North) passenger train 1548, which had departed Grand Central Terminal (GCT), New York, New York, headed toward New Haven, Connecticut, derailed from main track 4 at milepost (MP) 53.25 on the New Haven Line Subdivision 7. The derailed train was then struck by westbound Metro-North passenger train 1581, which had departed New Haven, Connecticut, bound for GCT. As a result of the collision, at least 65 persons were injured. Metro-North estimated about 250 passengers were on each train at the time of the accident. (See figure 1.)

Figure 1. Metro-North passenger trains: 1548 (right) and 1581 (left).

Emergency Response

At 6:02 p.m., the first 911 emergency call was received by the Fairfield Emergency Communications Center (Fairfield 911) in Fairfield, Connecticut. The call was from a passenger aboard the derailed eastbound train. Several additional calls were received from other train passengers. About the same time, the Bridgeport 911 call center received its first call from a motorist who was traveling on nearby Interstate 95 (I-95).

At 6:03 p.m., Fairfield 911 dispatched American Medical Response Fairfield County ambulance services and the Fairfield fire department. At 6:09 p.m., the Fairfield fire department arrived and established a command post. At 6:11 p.m., the first ambulance and the Bridgeport fire department arrived on scene. The Fairfield emergency responders directed the self-evacuated passengers to a nearby vacant lot, which served as a temporary holding area. Of the 65 injured passengers, 53 sustained minor injuries and 12 sustained serious injuries.

Trains Involved

Both Metro-North trains consisted of eight passenger railcars designated by Metro-North as M-8 series. The M-8 series passenger cars are self-propelled, electrically powered, and capable of operating on either an electrified third-rail or an overhead catenary system.

After the required predeparture brake tests, the eastbound train departed on schedule at 4:42 p.m. The train was operating on main track 4. Prior to the derailment, the last station stop for the train was the Fairfield Metro Station. After the train departed the Fairfield Metro Station, it accelerated to 74 mph. As the train approached MP 53.25, the locomotive engineer said that he thought he saw a track defect in the left rail under the I-95 overpass. The locomotive engineer told NTSB investigators he might have seen the track defect but it was too late to stop. All eight cars in the train derailed upright. The derailed third and fourth cars (9246 and 9247) encroached onto the adjacent main track. The engineer said that moments later he saw the westbound train pass on the adjacent track, and he felt the passing train strike his derailed train.

After the required predeparture brake tests, the westbound train departed New Haven Station at 5:35 p.m. After stopping at the Bridgeport Station on track 3, which was the last stop before the collision, the westbound train crossed over to main track 2 and accelerated to 74 mph as it approached MP 53.25. The engineer of the westbound train said that moments before the collision, he saw an arc and what he thought were falling catenary wires. He said that he immediately applied the emergency brakes of his train. As the westbound train slowed, its lead car (9193) collided with the third car (9246) in the eastbound train. The lead car of the westbound train sideswiped 9246, scraping the side of the car. At the time of impact, the westbound train had slowed to about 23 mph and the eastbound (derailed) train was completely stopped.

Broken Compromise Joint Bars

At the point of derailment, investigators found a pair of broken compromise joint bars on the north rail of main track 4. Compromise joint bars are used to join two rails of different sizes by compensating for the different heights of the two rail heads. (See figure 2.) The compromise joint was two separate bars that were bolted to the webs of the two rails. The two rails were 136- and 131-pound rails.[1] The compromise joint bars had been installed on April 4, 2013, during a scheduled joint bar inspection, to replace broken bars.

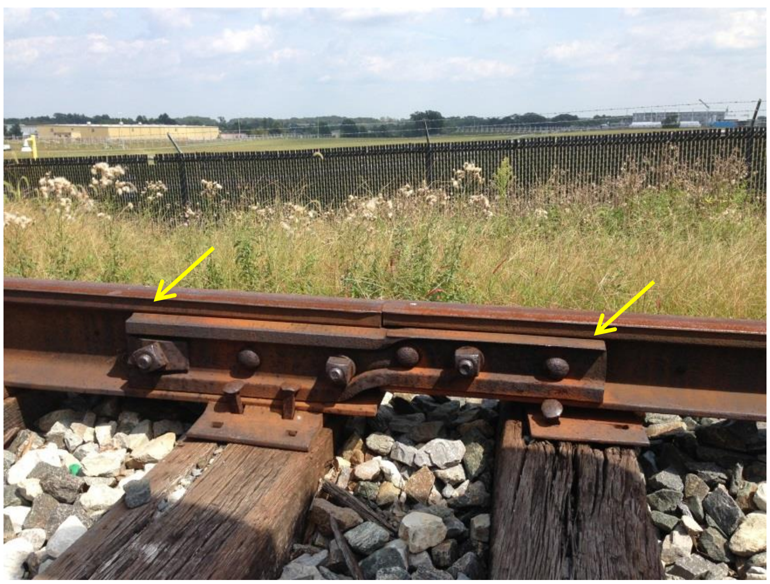

Figure 2. Photograph of an exemplar compromise joint bar denoted by arrows (not Metro-North).

[1] References to 136-pound rail and 131-pound rail refer to the rail section weight per yard.

The broken compromise joint bars were examined at the accident scene by NTSB investigators and in the NTSB Materials Laboratory in Washington, DC. The examination found that the gage side bar, which is the bar closest to the center line of the track, exhibited crack arrest marks indicative of fatigue cracking. The fatigue cracks emanated from multiple origins at the bottom of the bar. The compromise joint bar on the field side, which is the bar opposite the gage side, also contained a fatigue crack originating at the bottom of the bar. (See figure 3.) The fatigue propagation extended partially through the middle portions of the compromise joint bars.

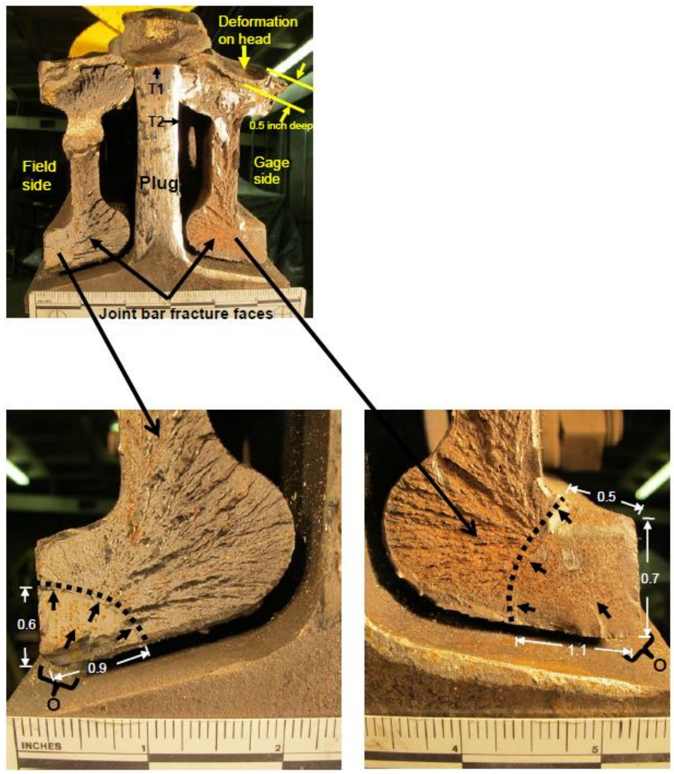

Figure 3. Fractured pair of compromise joint bars and rail showing the east fracture face (top photo) and close-up photographs of the leg portions of the compromise joint bars (bottom photo). A fatigue crack emanated from the lower corner of each leg portion of the compromise joint bars in the areas indicated by brackets "O."

By measuring the exposed portions of the fatigue cracks, investigators determined that the gage side bar, which had the largest and oldest fatigue crack, was the first bar to break. The exposed portions of fatigue cracks on the field side bar were smaller; this finding indicated that it was the second bar to break.

Investigators also measured the joined rails to determine whether the rail head running surfaces were properly matched. By design, the compromise joint bars create a 0.1875-inch difference at the base of the rails by raising the smaller rail. This action aligns and levels the rail head running surfaces. However, in this case, the 131-pound rail was worn. The running surface of the 131-pound rail was lower than that of the 136-pound rail; with a vertical rail end mismatch at the joint of about 0.3 inch. A mismatch of this magnitude should have been noticeable by sound and feel when traversed by an inspector in a hi-rail inspection vehicle. This mismatch also would have been noticeable to a trained inspector who walked the track. Federal Railroad Administration (FRA) regulations at Title 49 *Code of Federal Regulations* 213.115, "Rail End Mismatch," allow no more than a 0.125-inch mismatch on the tread (that is, head) of the rail end for a class 4 track.[2]

On May 15, 2013, 2 days before the accident, the last track inspection in the area of the derailment was performed from main track 2 by Metro-North track inspectors in a hi-rail vehicle.[3] The inspectors documented a "joint with hanging ties" (that is, insufficient ballast support) and "pumping under load" (that is, vertical deflection) at the location of the derailment on main track 4.[4] No corrective action was documented in the report. During an on-scene examination of the derailment area, NTSB investigators found conditions consistent with deflection under the joint. The NTSB investigators determined the combination of the rail-head mismatch and the vertical deflection under the joint caused the compromise joint bars to fail from fatigue cracking.

The gage side of the rail on main track 4, including the compromise joint bar, would not have been visible to the Metro-North inspectors riding in a hi-rail vehicle on main track 2. Also, the small crack at the bottom of the field side compromise joint bar on main track 4 would not have been visible to the track inspector because of the distance of the vehicle from main track 2.

Title 49 *Code of Federal Regulations* 213.233, "Track Inspections," requires an inspection frequency for class 4 track of twice weekly with at least one calendar day interval between inspections.[5] In addition, section 213.233(b) states, in part, the following with respect to a track inspection conducted by riding over the track in a vehicle:

> (2) Two inspectors in one vehicle may inspect up to four tracks at a time provided that the inspectors' visibility remains unobstructed by any cause and that each track being inspected is centered within 39 feet from the track upon which the inspectors are riding;
>
> (3) Each main track is actually traversed by the vehicle or inspected on foot at least once every two weeks, and each siding is actually traversed by the vehicle or inspected on foot at least once every month. On high density commuter railroad lines where track time does not permit an on track vehicle inspection, and where track centers are 15 foot or less, the requirements of this paragraph (b)(3) will not apply.

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[2] The track at MP 53.25 was class 4 track. The maximum allowable operating speed for a passenger train on class 4 track is 80 mph.

[3] The hi-rail vehicle used on the New Haven Line is a two-door pickup truck that is equipped with hydraulic operated hi-rail wheels and a multichannel bandwidth radio for communication with varying departments.

[4] The rail joint was held in place by joint bars.

[5] Metro-North normally inspects this track three times each week either on foot or using a hi-rail vehicle. The track was inspected twice during the week of May 12, 2013.

According to Metro-North track inspectors, the vast majority of track inspections were conducted from one of the two inside tracks (that is, main tracks 1 and 2). During those inspections, all four main tracks were inspected simultaneously by two track inspectors riding in a hi-rail vehicle. Metro-North track inspectors told NTSB investigators when they had an opportunity to inspect the outside tracks (that is, main tracks 3 and 4) while riding in a hi-rail inspection vehicle over those tracks, they had to rush in order to avoid impact to on-time train performance. This assertion was verified by the Metro-North Assistant Track Supervisor, who said the inspectors brought this issue to his attention. Another manager said that train density was increasing so much that it was difficult to schedule track maintenance. He said on-time train schedule performance took precedence.

At the NTSB's investigative hearing on November 7, 2013, the Metro-North Assistant Vice President of Maintenance of Way and Chief Engineer was asked when the last walking or hi-rail inspection was conducted by physically traversing main track 4 in the area of the derailment. He stated that, based on his review of records from January 2013 through May 17, 2013, he was unable to determine the last time main track 4 was physically walked or traversed by a hi-rail inspection vehicle.

The NTSB previously has expressed concern about the adequacy of simultaneous inspection of multiple tracks and the importance of physically riding over the inspected track. In its December 18, 2012, comments on the FRA Notice of Proposed Rulemaking, titled "Track Safety Standards; Improving Rail Integrity," the NTSB explained the basis for this concern as follows:

> When inspecting track from a typical hi-rail vehicle, an inspector can see the track structure in front from about 20 feet. In addition to operating the vehicle and looking in the direction of travel for track defects 20 feet in front, an inspector may be expected to inspect an adjacent track up to 30 feet to the side. Furthermore, part of the inspection may include the sound or feel of the track as the inspection vehicle rides over the track. These parts of the inspection are not performed if the inspector is inspecting [from] adjacent track. In addition, most defective track conditions occur after a period of gradual deterioration and are not observed during a single inspection cycle, although some conditions become visible to normal inspection when there is a rapid failure. The most important cause of track structure deterioration is rail traffic; the more severe the traffic conditions—measured by total tonnage, individual loads, car conditions, train handling, and speed—the greater the rate of deterioration will be. The NTSB believes that both gradual deterioration and rapid failures can create serious hazards, and the probability of detecting these hazards is substantially reduced when multiple tracks are being inspected simultaneously.

Postaccident Actions

On May 19, 2014, the NTSB issued the following recommendation to the FRA as a result of this accident:

(R-14-11)

> Revise the Track Safety Standards specified in Title 49 *Code of Federal Regulations* 213.233(b)(3), removing the exemption for high-density commuter railroads and requiring all railroads to comply with these requirements: (1) to traverse each main track by vehicle or inspect each main track on foot at least once every 2 weeks, and (2) to traverse and inspect each siding, either by a vehicle or on foot, at least once every month.

On May 19, 2014, the NTSB also issued the following recommendation to Metro-North:

(R-14-12)

> Revise your track inspection program to include requirements (1) to traverse each main track by vehicle or inspect each main track on foot at least once every 2 weeks, and (2) to traverse and inspect each siding, either by vehicle or on foot, at least once every month.[6]

After the accident, Metro-North initiated a number of specific actions related to the state of its track repair, one of which was the assessment of its system immediately following the accident in Bridgeport. Metro-North contracted the Transportation Technology Center, Inc. (TTCI), an internationally recognized research arm of the American Association of Railroads, for a comprehensive assessment of its track infrastructure and maintenance program. The TTCI provided a set of recommendations on improving Metro-North track inspection and maintenance. Metro-North provided the NTSB with an action plan on these recommendations that included better quality control of track inspections, using gage restraint measurement systems, increased use of track geometry vehicles, and moving to automated record keeping for track inspection data.

Probable Cause

The NTSB determined that the probable cause of the derailment was an undetected broken pair of compromise joint bars on the north rail of track 4 on the Metro-North Railroad New Haven subdivision at milepost 53.25 resulting from: (1) the lack of a comprehensive track maintenance program that prioritized the inspection findings to schedule proper corrective maintenance; (2) the regulatory exemption for high-density commuter railroads from the requirement to traverse the tracks they inspect; and (3) Metro-North's decisions to defer scheduled track maintenance.

For more details about this accident, visit www.ntsb.gov/investigations/dms.html and search for NTSB accident ID DCA13MR003.

[6] Safety Recommendations R-14-11 and -12 are currently classified "Open—Await Response."

Adopted: October 24, 2014

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

CHRISTOPHER A. HART
Acting Chairman

ROBERT L. SUMWALT
Member

MARK R. ROSEKIND
Member

EARL F. WEENER
Member

The NTSB has authority to investigate and establish the facts, circumstances, and cause or probable cause of a railroad accident in which there is a fatality or substantial property damage, or that involves a passenger train. (49 U.S. Code § 1131 - *General authority*)

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties . . . and are not conducted for the purpose of determining the rights or liabilities of any person." 49 *Code of Federal Regulations*, Section 831.4. Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report. 49 *United States Code*, Section 1154(b).

7.2 Appendix B – Brief of Employee Fatality in West Haven (May 28, 2013)

National Transportation Safety Board

Railroad Accident Brief

Metro-North Railroad Employee Fatality

Accident No.:	DCA13FR005
Location:	West Haven, Connecticut
Date:	May 28, 2013
Time:	11:57 a.m. eastern daylight time
Railroad:	Metro-North Railroad
Property damage:	Negligible
Injuries:	0
Fatalities:	1
Type of accident:	Employee fatality

The Accident

On May 28, 2013, at 11:57 a.m. eastern daylight time, Metro-North Railroad (Metro-North) passenger train 1559, which was traveling westbound at 70 mph on the New Haven Line main track 1, struck and killed a track foreman in West Haven, Connecticut.[1] The accident location was about 100 feet west of catenary bridge 1021 at milepost 69.56.

At the time of the accident, the weather was 67°F, wind speed was 6 mph, and the sky was overcast. Metro-North reported minimal equipment damages.

The track foreman reported for work at 8:00 a.m. on the day of the accident. He was briefed by a supervisor; he, in turn, briefed the crew with which he would be working that day. The work plan involved relocating segments of rail from main track 1 to industrial track 5 in the vicinity of the new West Haven Station using a crane. This work was in preparation for the raising and resurfacing of track 1.

At 10:41 a.m., the track foreman contacted a Metro-North rail traffic controller (RTC) at the Operations Control Center (OCC) to request that main track 1 be removed from service between control point (CP) 266 and CP 271. To fulfill this request, the RTC placed blocking

[1] All times referenced in this report are eastern daylight time.

devices to prevent trains from entering the area.[2] At 10:42 a.m., the RTC issued authority to the foreman that took main track 1 out of service between CP 266 and 271 until 4:00 p.m. This action provided the foreman an exclusive work area on main track 1. In accordance with Metro-North procedures, the track could not be returned to service until the foreman released this authority back to the RTC.

About 10:45 a.m., the track supervisor informed the track foreman that no one was available to remove overhead power. Without overhead power removed, the height to which the crane boom could be raised was limited. (The overhead catenary wires are typically about 17 feet above the center line of the rail.)

At 10:55 a.m., the track foreman contacted the RTC to request authority to move the crane from CP 257 to CP 266.[3] At 10:56 a.m., the RTC issued a separate authorization to the foreman that granted permission to move on main track 2 from CP 257 to CP 266. This move was completed at 11:26 a.m.

The foreman requested permission from the RTC to proceed into the interlocking to move the crane from main track 2 west to main track 1 and then east into the exclusive work area. After the authority was granted, the foreman moved the crane. By 11:45 a.m., the crane cleared CP 271 and was positioned on industrial track 5. (See figure 1.)

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[2] *Blocking devices* are electronic locks applied in the OCC to prevent the routing of trains onto tracks. Applying and removing a blocking device involves clicking on a drop-down menu on a computer screen. When a blocking device is applied, an indication shows on the RTC's screen at the location where it is applied.

[3] An RTC works a specific section of a railroad referred to as a desk. Each desk or division is managed by a different RTC.

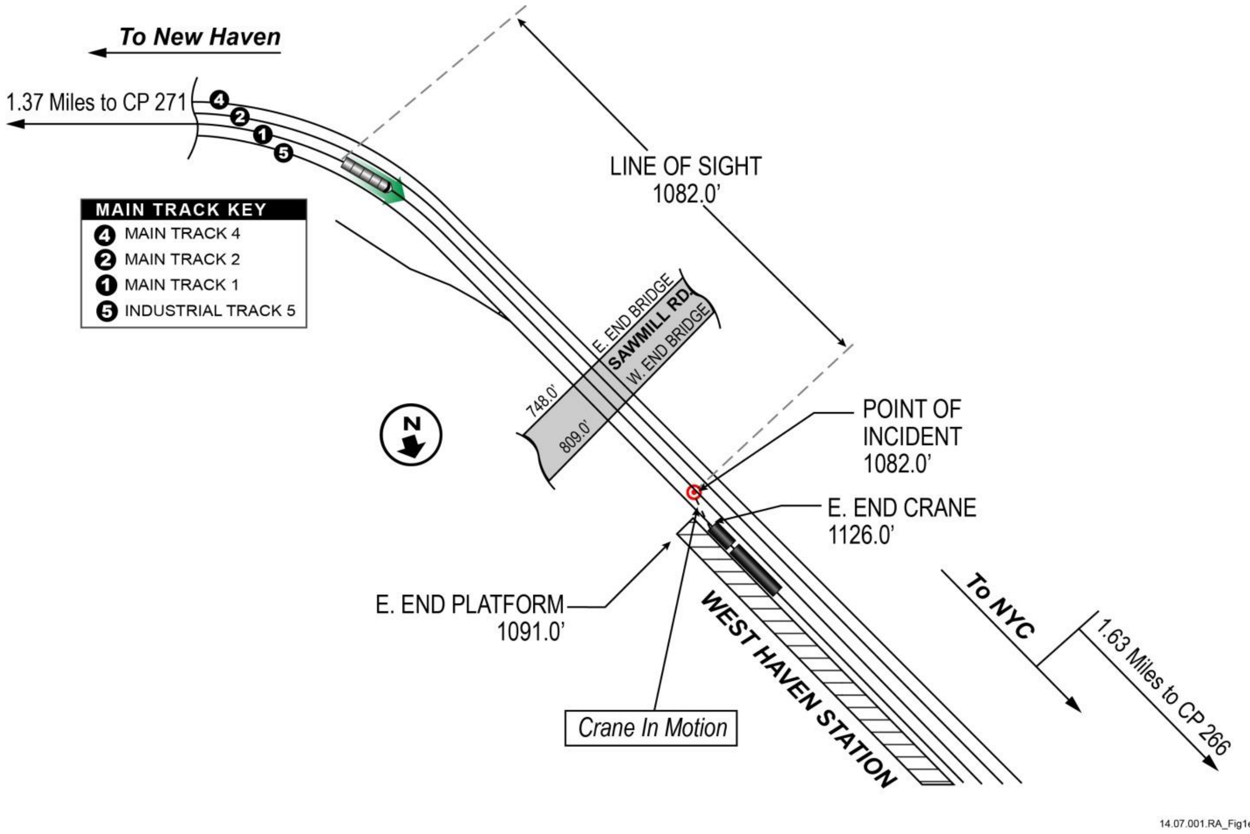

Figure 1. Accident area track diagram.

Once on industrial track 5, the foreman reported to the RTC that he was in the clear of the interlocking on track 5 and proceeded west with the crane to the work site at the West Haven Station platform. At this location, the foreman and the crane operator decided to work from industrial track 5 and to operate the crane with a low boom, so they would not need to remove power from the overhead catenary wires above the main tracks.[4] After they verified that the crane could swing without contacting the station platform, they began moving rail from main track 1 to industrial track 5. This effort required the foreman to manually attach rail tongs to the rail on track 1. The crane would pick up the rail and move the rail onto industrial track 5. The crew worked in a westerly direction with the crane facing east and the foreman facing west. (See figure 2.)

[4] The Metro-North rules specified a minimum 10-foot separation between the boom and the energized catenary line.

Figure 2. Westward view of work location and crane.

As the crane operator began moving rail from main track 1 to industrial track 5, the crane operator heard the horn of a train approaching from the east. The crane operator and the track foreman continued to look to the east and observe the approaching train. The crane operator told investigators that he could not tell which track the train was on due to a curve in the tracks. He said that he returned his attention to his work because main track 1 was out of service. However, as the train neared, he realized that the train was on main track 1. He tried to warn the track foreman by yelling for him to run. The operator moved the boom clear of main track 1 just before the train arrived, thus minimizing the hazard to the train and its passengers. However, the track foreman did not clear the track. The train struck and killed the foreman, and it struck the rail that was draped over the north rail of main track 1; this collision with the rail knocked the remainder of the rail into the center ditch between main track 1 and industrial track 5.

The event recorder data shows that the striking train was moving 70 mph as it approached the accident site. The authorized maximum speed was 75 mph. The engineer of train 1559 stated that he sounded his train horn in anticipation of workers being at the West Haven Station construction area. He stated that as he came around the curve he first saw the boom of the crane fouling main track 1. He then said he observed the white hard hat of a worker standing between the rails of main track 1. The engineer continuously sounded the horn and made an emergency brake application before striking the foreman and the rail.

The sight-distance test conducted by NTSB investigators showed that the train engineer would have had a view of the foreman and rail from a distance of about 1,082 feet. The stopping distance for the train was measured at 2,423 feet.

The engineer of train 1559 said that he previously had conducted an initial brake test in New Haven Yard prior to the departure from the yard. At that time, the train brakes functioned as intended. Between the yard and the New Haven station, he conducted a running brake test.[5] He conducted a second running brake test after departing the New Haven station. In both running brake tests, no exceptions were noted. He also said that during the emergency brake application prior to impact, the brakes functioned as intended.

The investigation determined that the following were not factors in the accident: signal system defects, the track condition, the train mechanical condition, the actions of the Metro-North engineer, and the actions of the Metro-North track foreman.

Rail Traffic Controller Procedures

Two RTCs at the OCC were responsible for the accident location. One was a student RTC, who had been hired in November 2012 and was working under the mentorship of a qualified RTC. The student RTC was receiving on-the-job training at the desk and was the employee who applied the electronic blocking devices for this work crew and issued the authority to the foreman. At 11:47 a.m., the student RTC removed the blocking device on main track 1 between CP 266 and CP 271 without first following the proper procedures for canceling the authority that had been issued to the track foreman. The qualified RTC responsible for supervising the student said that he did not see the student RTC remove the blocking device. At the time the block was removed, he said he may have momentarily stepped away from the desk.

The student RTC said that when he heard the foreman state that he was in the clear on industrial track 5 (that is, the crane was on industrial track 5 and clear of main track 1), he took that to mean that it was okay to remove the blocking device from main track 1. After the blocking device was removed about 11:51 a.m., the student RTC aligned a route for train 1559 to proceed westbound into the area where the track foreman was moving rail from main track 1.

Toxicological samples from the engineer, the student RTC, the mentor RTC, and the killed foreman were tested in accordance with federal regulations. The test results were negative for both illicit drugs and alcohol.

Prior to this accident, on May 4, 2013, a similar error occurred when an RTC incorrectly removed the blocking devices from an occupied track. This earlier incident did not result in damage or injury. On May 6, 2013, Metro-North instituted additional operation control procedures, including a software enhancement that required RTCs to validate their intent to release track authorizations before removing the blocking devices. The student RTC used this

[5] Title 49 *Code of Federal Regulations* 238.319 states, "a running brake test shall be conducted in accordance with railroad's established operating rules, and shall be made by applying brakes in a manner that allows the engineer to ascertain whether the brakes are operating properly when the train is moving."

feature to validate his intent to release the track authority in this instance but still released the authority in error.

Postaccident Actions

On June 17, 2013, the NTSB issued the following urgent safety recommendation to Metro-North:

(R-13-17) Urgent

> Immediately implement redundant signal protection, such as shunting, for maintenance-of-way work crews who depend on the train dispatcher to provide signal protection.[6]

The recommendation is currently classified "Open—Acceptable Response."

In addition, the NTSB reiterated Safety Recommendation R-08-6 made to the FRA. That recommendation was issued as a result of the 2007 Massachusetts Bay Transportation Authority accident that killed two track workers at Woburn, Massachusetts:

(R-08-6)

> Require redundant signal protection, such as shunting, for maintenance-of-way work crews who depend on the train dispatcher to provide signal protection.[7]

After the accident, Metro-North designated a dedicated OCC manager to approve all blocking device applications and removals before authority to foul a track is either granted or rescinded. Metro-North also reinstituted the use of a handwritten blocking device authority form as an additional safeguard against the improper removal of a blocking device. The RTC must record the details of the blocking device removal on the blocking device authority form.

In addition, Metro-North (with a technology vendor) developed the Enhanced Employee Protection System (EEPS).[8] The EEPS is an automated system that allows employees in the field to control the application and removal of blocking devices by use of a random, computer-generated code known only to that employee. Before the RTC can release a blocking device, the employee in the field must provide the unique code and the RTC must type it into the system. On April 3, 2014, EEPS was implemented system-wide.

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[6] *Shunting* involves making an electrical connection between the two running rails to simulate the presence of a train, typically with a cable. Shunting causes the signal system to display stop indications to trains approaching the area where shunts are applied.

[7] National Transportation Safety Board, Collision of Massachusetts Bay Transportation Authority Train 322 and Track Maintenance Equipment, Woburn, Massachusetts, January 9, 2007, RAR-08/01 (Washington, DC: National Transportation Safety Board, 2008).

[8] This system was in addition to, and separate from, the software enhancement developed after the May 4, 2013, event.

Metro-North also reported that the guidelines for the supervision of a student RTC while receiving on-the-job training have been examined and improved. Students are no longer permitted to apply or remove blocking devices without the permission of a qualified RTC. A daily evaluation form is to be completed so further assessment of the student's performance can be reviewed by the instructor.

Written instructor guidelines were developed to ensure uniformity and consistency in the training. In addition, a simulator was designed and incorporated into the training program in order to simulate real-world scenarios.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the student rail traffic controller's removal (while working without direct supervision) of signal blocking protection for the track segment occupied by the track foreman and the failure of Metro-North to use any redundant feature to prevent this single point failure. Contributing to the accident was the Federal Railroad Administration's failure to require redundant signal protection, as recommended by Safety Recommendation R-08-6.

For more details about this accident, visit www.ntsb.gov/investigations/dms.html and search for NTSB accident ID DCA13FR005.

Adopted: October 24, 2014

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

CHRISTOPHER A. HART
Acting Chairman

ROBERT L. SUMWALT
Member

MARK R. ROSEKIND
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7.3 Appendix C – Brief of CSX Derailment in the Bronx (July 18, 2013)

National Transportation Safety Board

Railroad Accident Brief

Metro-North Railroad Derailment

Accident No.:	DCA13FR009
Location:	Bronx, New York
Date:	July 18, 2013
Time:	8:29 p.m. eastern daylight time
Railroad:	CSX and Metro-North Railroads
Property damage:	$827,700
Injuries:	0
Fatalities:	0
Type of accident:	Derailment

The Accident

On July 18, 2013, at 8:29 p.m. eastern daylight time, northbound CSX Transportation (CSX) train Q70419, derailed on the Metro-North Railroad (Metro-North) Hudson Line at milepost (MP) 9.99 on main track 2.[1] The train consisted of 2 locomotives and 24 modified flat cars. Each flat car was loaded with 4 containers containing municipal refuse. The 11th through 20th cars derailed.

Northbound Metro-North train 781 was stopped on main track 1 at Marble Hill Station (MP 9.8) when the CSX train passed.[2] The Metro-North engineer reported seeing sparks and dust flying when the CSX train derailed. He also reported seeing no dragging equipment or anything unusual prior to seeing the sparks and dust.

There were no injuries. CSX and Metro-North estimated the damage at $827,700. The weather at the time of the accident was 91°F and clear. The National Weather Service had issued a heat advisory from July 14 to 18, 2014.

[1] All times in this report are in eastern daylight time.

[2] Metro-North rules require employees to observe passing trains whenever possible for defects or unusual conditions.

Brief Narrative

The crew, consisting of an engineer, student engineer, conductor, and conductor trainee, took charge of the CSX train at the CSX Oak Point Yard in The Bronx, New York, at 6:30 p.m. After entering Metro-North tracks, the train proceeded north on main track 4. The crew encountered a stop signal at CP 10. The engineer said that he slowed the train using dynamic brakes and was almost to a stop when the signal changed to clear. The routing at CP 10 took the CSX train through a turnout (that is, a diverging switch) from main track 4 to main track 2. The engineer said that he increased the throttle in steps to full throttle, and when the maximum authorized speed of 15 mph was achieved, he reduced the throttle in steps to idle.[3] He told investigators that this was his usual technique – to get up to speed and then "drift" through the banked curve. Then, he again would gradually increase throttle as the train was slowed by the curves. As the speed reduced, the engineer began increasing the throttle in steps. At that time, he received a radio call from Metro-North train 781, which was stopped at Marble Hill Station on track 1, informing him that his train (CSX train) had derailed cars.

The CSX engineer said he immediately applied the full service air brake and shortly thereafter the train went into emergency braking. He said that he immediately made an emergency radio transmission. Upon making a walking inspection, the conductor determined that the 11th through the 20th cars had derailed on main track 2 and that derailed equipment was blocking main track 1. (See figure 1.)

Figure 1. Derailed cars in cut (left). Point of derailment area (right).

[3] Event recorder data indicate that the train reached a speed of 19 mph before beginning to slow.

Track Image Recorders

Both CSX locomotives were equipped with forward-facing video recorders.[4] The video from the leading locomotive had insufficient detail for close track examination. The video from both the front and rear locomotives showed movement consistent with a slight dip (that is, a low spot in the track) to the west in the general vicinity of the point of derailment (POD). The video from the rear locomotive did not show any other unusual movements of the first car in the train.

Track

The POD was determined by a wheel flange mark on the inside base of the west (low) rail at MP 9.99 (72 feet 10 1/4 inches north of CP 10). (See figures 2 and 3.)

Figure 2. Marks on gage side of base of low rail at point of derailment highlighted by arrows.

[4] The second locomotive was traveling backward so the video was facing the first car in the train.

Figure 3. Point of derailment showing a slight outward bow as compared with the straight yellow line.

In the vicinity of the POD, the tracks run parallel to the Harlem River and have a negligible grade. Track in this area was designated by Metro-North as Class 2 track.[5] Maximum train speeds were 30 mph for passenger trains and 15 mph for freight trains.

The track at the POD is continuous welded rail fastened on concrete ties with Pandrol low shoulder clips and supported by crushed trap rock ballast.[6] The crosstie spacing is 24 inches on center.

The concrete ties in the POD area were installed in 2000, and the track was last surfaced in 2004. Metro-North interviews revealed that the railroad's cyclic maintenance program for tie replacement was on a 6- to 7-year schedule, and surfacing was on a 3-year schedule. At the NTSB investigative hearing on November 7, 2013, Metro-North's Assistant Vice President and Chief Engineer stated that Metro-North was:

> … behind in several areas of our programs and tie cycles and surfacing are two of those areas, as are some of the other programs. I can't give you an answer as to how we got so far behind, but we're working towards getting back into phase.[7]

In the vicinity of the POD, investigators noted that the clip insulators on the field side of the rail had slipped out of place, so they were incorrectly positioned above the base of the rail on

[5] FRA classifies track by number to indicate allowable train speeds and maintenance standards. Class 2 track allows passenger train speeds of 30 mph and freight train speeds of 25 mph. Metro-North further reduced allowable freight train speeds to 15 mph.

[6] Pandrol is a brand of track fasteners used on many railroads.

[7] Transcript of Hearing 11-6-13, p. 36.

a number of ties. With the bottom of the insulator above the rail base, a gap is created allowing the rail to move further outward and thereby widening the gage by approximately 5/16 inch.

Figure 4. Diagram showing proper installation of Pandrol insulators (shown in yellow) and clips (shown in red). The rail is shown in grey. (Source: Pandrol brochure)

Figure 5. Proper installation of a Pandrol clip and insulator.

Figure 6. Insulator between Pandrol clip and rail base. Note that bottom portion of the insulator in the image in the foreground has slipped above base of rail on field side creating a gap.

Soil intrusion into the ballast (fouled ballast) was noted in the derailment area.[8] Fouled ballast occurs when inadequate drainage results in a buildup of water in the track substructure. Hydraulic action ("pumping") during train movements over the area results in fine soil particles rising to the surface and contaminating the ballast. In addition, the movement of the ties in the ballast can cause abrasion of the ties. The gray powdery substance that was observed throughout the track structure in the POD area appeared to be from concrete tie abrasion. Over time, pumping and fouled ballast conditions worsen and provide less structural support to the ties and track.

Satellite images from June 2010 (3 years before the derailment) showed the fouled ballast at the point of derailment, indicating fouled ballast at the POD was not a recent phenomenon.[9]

[8] The white material is a combination of ballast and concrete dust mixed with soil. The concrete dust is formed by the movement of the ties against the ballast as the track "pumps" during train movement.

[9] Google Earth screen shot dated June 17, 2010.

Figure 7. 2010 Satellite image showing fouled ballast at the POD (that is, the white areas inside red circles).

Figure 8. 2011 Satellite image showing fouled ballast at POD.

A similar image about 1 year later shows the POD fouled ballast more clearly.[10]

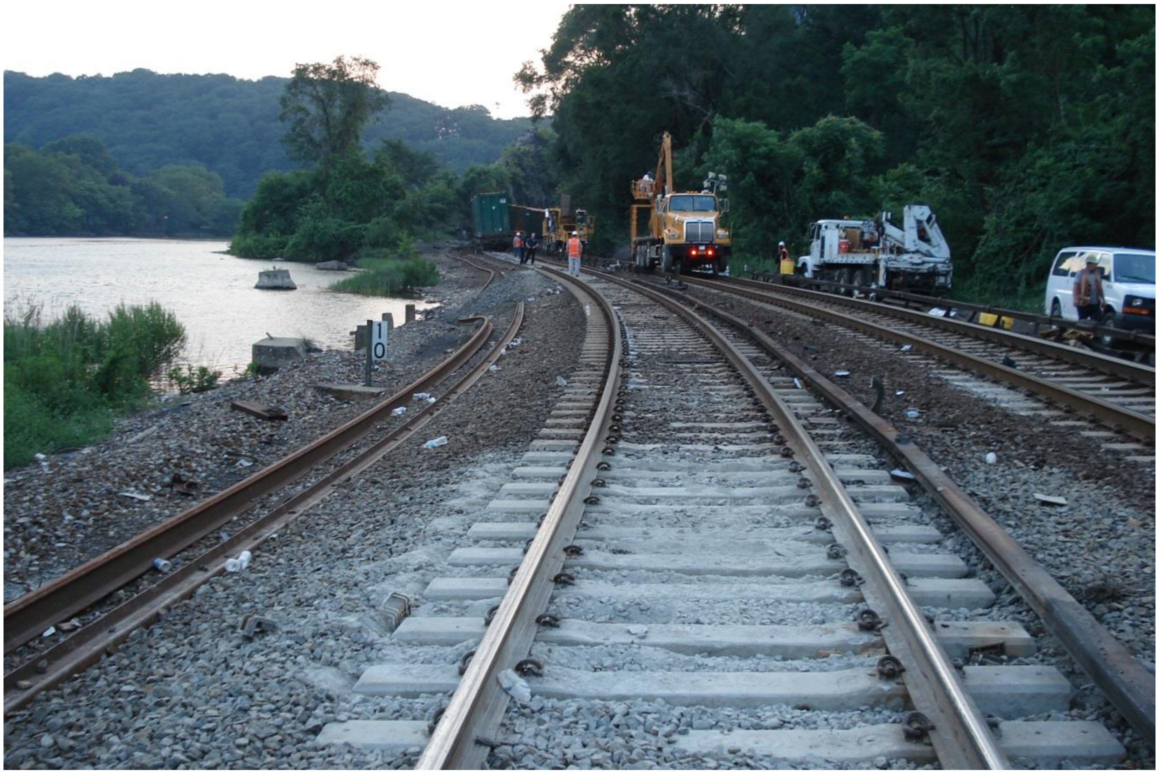

Figure 9: Close up of fouled ballast in POD area.

Following the train derailment in Bridgeport, Connecticut, on May 17, 2013, Metro-North hired the Transportation Technology Center, Inc. (TTCI) to evaluate the Metro-North track maintenance program. As part of that evaluation, TTCI conducted a survey of track areas with poor drainage. The survey identified 654 locations on the Metro-North system with poor drainage and fouled ballast, including the accident location.

The Federal Railroad Administration (FRA) DOTX 220 track geometry car was used to inspect the area of the derailment on June 4, 2013. The inspection report disclosed no exceptions to FRA track geometry regulatory standards. A review of the strip chart from the inspection revealed a profile measurement of 2 inches (that is, a dip) in both rails in the derailment area and a gage of 57.81 inches; both measurements were within tolerance.[11] The maximum allowable profile measurement is 2 3/4 inches in Class 2 and the maximum allowable gage for Class 2 is 57 3/4 inches.

Metro-North conducted a walking inspection of the derailment area on July 18, 2013, prior to the derailment. The inspection report did not include any reportable track defects in the

[10] Google Earth screen shot dated June 2, 2011.

[11] Track geometry car measurements are in decimal form while track standards are listed in fractions. The track geometry car equipment uses laser scanning at 1-foot intervals, which sometimes spike and register false positives. For the equipment to highlight a gage defect, the gage must be .1 inch or greater over tolerance or exceed tolerance for several feet.

POD area.[12] However, consistent with the fouled ballast and inadequate drainage discussed above, the inspection report noted, "MP11.4, track 1 has a mud spot, MP 10.1, track 2 has a mud spot and a 1/2-inch profile deviation, MP 10.2, track 2 two broken ties and surfacing needed." The inspection record did not note any exceptions at MP 9.99 on track number 2.

Track panels from the derailment site were preserved and later disassembled at Metro-North High Bridge Yard. Wear in the rail seat area was noted on many of these ties along with a worn trough on the field side of the rail seat. (See figure 10.) This wear was indicative of the rail canting outward.

Figure 10. Groove worn into field side of rail seat.

Center cracking was evident on a number of ties. (See figure 11.) Center cracking on concrete ties is an indication that the ties are center bound, meaning that there is inadequate support at the ends of the ties and that they can flex or bow under loads. When ties bow, the track gage increases because the rails cant outward.

[12] Metro-North used the FRA track standards as the criteria for reportable defects.

Figure 11. Cracks at centers of ties at POD. (Gage rod was installed after the derailment.)

The cross section of the ties was reduced by abrasion on the bottom of the ties, and the reduced cross section was more pronounced at the ends of ties at the inside of the curve. Steel tensioning strands were exposed on the ends of many ties. (See figure 12.) More pronounced loss of cross section at the ends of ties indicates more movement and abrasion against the ballast and is another indication of less support at the ends of ties than in the center.

Figure 12. Tie from POD area (left) with reduced cross section and exposed tension strands and unused exemplar tie (right).

The investigation determined that the following were not factors in the accident: the signal system; the train mechanical condition; the actions of the CSX train crew in handling the train; the actions of the Metro-North rail traffic controller; and the weight and loading of the containers.

Metro-North Postaccident Actions

As mentioned above, following the Bridgeport derailment, Metro-North contracted with TTCI to conduct a comprehensive review of the entire track maintenance program. TTCI produced a series of reports in early 2014, which included specific recommendations to improve the Metro-North track maintenance program. Metro-North provided an action plan.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was excessive track gage due to a combination of fouled ballast, deteriorated concrete ties, and profile deviations resulting from Metro-North's decision to defer scheduled track maintenance.

For more details about this accident, visit www.ntsb.gov/investigations/dms.html and search for NTSB accident ID DCA13FR009.

Adopted: October 24, 2014

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

CHRISTOPHER A. HART
Acting Chairman

ROBERT L. SUMWALT
Member

MARK R. ROSEKIND
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The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties . . . and are not conducted for the purpose of determining the rights or liabilities of any person." 49 *Code of Federal Regulations*, Section 831.4. Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report. 49 *United States Code*, Section 1154(b).

7.4 Appendix D – Brief of Metro-North Derailment in the Bronx (December 1, 2013)

National Transportation Safety Board

Railroad Accident Brief

Metro-North Railroad Derailment

Accident No.:	DCA14MR002
Location:	Bronx, New York
Date:	December 1, 2013
Time:	7:19 a.m. eastern standard time
Railroad:	Metro-North Railroad
Property damage:	$9 million
Injuries:	61
Fatalities:	4
Type of accident:	Derailment

The Accident

On Sunday, December 1, 2013, at 7:19 a.m. eastern standard time, southbound Metro-North Railroad (Metro-North) passenger train 8808 derailed at milepost 11.35 on main track 2 of the Metro-North Hudson Line.[1] The train originated in Poughkeepsie, New York, with a destination of Grand Central Station in New York, New York. The train consisted of seven passenger cars and one locomotive; the locomotive was at the rear of the train in a push configuration. All passenger cars and the locomotive derailed. The derailment occurred in a 6° left-hand curve where the maximum authorized speed was 30 mph. The train was traveling at 82 mph when it derailed. As a result of the derailment, 4 people died and at least 61 persons were injured. Metro-North estimated about 115 passengers were on the train at the time of the derailment.

Metro-North estimated damages at more than $9 million. At the time of the accident, the weather was 39°F, cloudy skies, and clear visibility.

[1] All times in this brief are eastern standard time.

Brief Narrative

The Metro-North crew reported for duty at Poughkeepsie at 5:04 a.m. The crew took charge of train 8808 and departed Poughkeepsie en route to Grand Central Station. The train made its first stop at New Hamburg, and then made eight additional stops prior to the derailment. Train 8808 made its last stop at Tarrytown, New York, which is about 14 miles north of the accident site.

Upon passing Riverdale, about 2 1/2 miles north of the accident site, the engineer increased the train speed to 70 mph. The engineer maintained full throttle, and the train speed increased to 82 mph. As the train entered a 30-mph curve at milepost 11.4, the train derailed. During the derailment sequence many of the cars slid on their right sides in the direction of travel, and window glazing (panes) detached from the cars. Based on the locations of the four passengers who died at the end of the accident sequence, the extent of dirt and plant material in wounds and the nature of their injuries, all four were completely or partially ejected from the train through window openings. In addition, two of the seriously injured passengers sustained severe injuries consistent with contacting the ground outside the train as the cars slid along the ballast.

The engineer later told investigators that he remembered feeling “dazed” or “hypnotized” just before the derailment. The train brakes were not applied before the derailment.

Figure 1. Accident scene.

The investigation determined that the following were not factors in the accident: signal system defects; the track condition; the train's mechanical condition; and the actions of the Metro-North rail traffic controller.

Engineer Medical Condition

Metro-North medical records indicate that the engineer had passed all required physical examinations. The engineer's personal medical records indicate that he had complained of fatigue prior to the accident and had been diagnosed with low testosterone and later hypothyroidism. He was obese with a body mass index of 36.4 in the week following the accident.[2] During interviews following the accident, the engineer reported that his wife had complained of his snoring.

After the accident, the engineer had a sleep evaluation that identified excessive daytime sleepiness and underwent a sleep study that resulted in a diagnosis of severe obstructive sleep apnea (OSA). The engineer had multiple OSA risk factors, including obesity, male gender, snoring, complaints of fatigue, and excessive daytime sleepiness. Although the engineer had these multiple risk factors and multiple visits with health care providers, neither his personal medical providers nor his occupational health evaluations by Metro-North identified his OSA.

Following the sleep study, successful treatment of the engineer's OSA was accomplished within 30 days of the diagnosis.

The Metro-North medical protocols and the Federal Railroad Administration (FRA) regulations in place at the time of the accident required triennial vision and hearing testing but did not require screening safety sensitive personnel for sleep disorders or any other medical conditions.[3]

Engineer Work Shift Change

Beginning on November 18, 2013, less than 2 weeks before the accident, the engineer's work schedule changed dramatically as a result of a routine job bid process, called the "pick."[4] After more than 2 years working shifts beginning in the late afternoon or evening and ending in the early morning, the engineer began to work shifts that that began in the dark of early morning (4-5 a.m.) and continued until early afternoon. Adjusting to a new wake/sleep schedule can take days or longer, depending on the difference between the previous and current schedules and the quality of restorative sleep obtained. The engineer told investigators that on his new work schedule he began to awaken around 3:30 a.m. and retire between 8:00 p.m. and 8:30 p.m. His wake/sleep cycle had now shifted about 12 hours. The engineer reported that his wake and sleep times varied in the days preceding the accident around the Thanksgiving holiday, which could have degraded his quality and quantity of sleep. Given the substantial shift in work schedules and

[2] Body mass index (BMI) calculation is based on height and weight. A BMI of 25–30 is considered overweight, and a BMI over 30 is considered obese.

[3] Safety-sensitive positions are defined in FRA regulations at 49 CFR 209.303.

[4] As part of a collective bargaining agreement, Metro-North train crew work assignments are re-opened for seniority bid twice each year.

the varied sleep/wake times, it is likely that the engineer had not adjusted fully to the new work schedule at the time of the accident. The engineer's OSA combined with his incomplete adjustment to a dramatic shift in work schedule most likely resulted in him being fatigued at the time of the accident.

Postaccident Actions

FRA Emergency Order 29 and Safety Advisory 2013-08

During the on-scene investigation, NTSB investigators determined that Metro-North trains exceeding the prescribed speed limits were not uncommon. As a result, on December 11, 2013, the FRA issued Emergency Order 29 which required Metro-North to take a number of immediate steps to ensure trains were not operated at an excessive speed. The FRA also issued Safety Advisory 2013-08 to all railroads on December 16, 2013, recommending that the railroads emphasize speed compliance to the operating employees.

Metro-North Train-Speed Enforcement Program

As a result of information developed during the on-scene NTSB investigation, Metro-North developed and implemented a train-speed enforcement program that involved radar speed checks and increased reviews of event-recorder data to confirm that engineers were adhering to speed limits.

FRA Safety Assessment of Metro-North

As a result of information obtained during this NTSB accident investigation and three additional ongoing NTSB Metro-North investigations, the FRA assembled a team to conduct a safety assessment of Metro-North operations. The FRA team interviewed Metro-North personnel, inspected Metro-North equipment, and reviewed Metro-North compliance with regulations. In March 2014, the FRA issued a report, *Operation Deep Dive, Metro-North Commuter Railroad Safety Assessment*, that contained a number of recommendations for improving safety on Metro-North. On May 15 2014, Metro-North submitted a response to the FRA addressing the recommendations in the FRA safety assessment report.

NTSB Recommendations

On February 18, 2014, the NTSB issued safety recommendations to Metro-North recommending the installation of permanent speed restriction signs, inward- and outward-facing audio and image recorders, and the use of the recordings to verify crew compliance with safety rules.[5]

[5] For more information, see the NTSB letter, dated February 18, 2014, to Metro-North in which the NTSB issued Safety Recommendations R-14-7 through -9. Safety Recommendation R-14-07 is classified *Open—Unacceptable Response* and Safety Recommendations R-14-08 and -09 are classified *Open—Acceptable Response*.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the engineer's noncompliance with the 30-mph speed restriction because he had fallen asleep due to undiagnosed severe obstructive sleep apnea exacerbated by a recent circadian rhythm shift required by his work schedule. Contributing to the accident was the absence of a Metro-North Railroad policy or a Federal Railroad Administration regulation requiring medical screening for sleep disorders. Also contributing to the accident was the absence of a positive train control system that would have automatically applied the brakes to enforce the speed restriction. Contributing to the severity of the accident was the loss of the window glazing that resulted in the fatal ejection of four passengers from the train.

For more details about this accident, visit www.ntsb.gov/investigations/dms.html and search for NTSB accident ID DCA14MR003.

Adopted: October 24, 2014

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

CHRISTOPHER A. HART
Acting Chairman

ROBERT L. SUMWALT
Member

MARK R. ROSEKIND
Member

EARL F. WEENER
Member

The NTSB has authority to investigate and establish the facts, circumstances, and cause or probable cause of a railroad accident in which there is a fatality or substantial property damage, or that involves a passenger train. (49 U.S. Code § 1131 - *General authority*)

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties . . . and are not conducted for the purpose of determining the rights or liabilities of any person." 49 *Code of Federal Regulations*, Section 831.4. Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report. 49 *United States Code*, Section 1154(b).

7.5 Appendix E – Brief of Employee Fatality in Manhattan (March 10, 2014)

National Transportation Safety Board

Railroad Accident Brief

Metro-North Railroad Employee Fatality

Accident No.:	DCA14FR006
Location:	Manhattan, New York
Date:	March 10, 2014
Time:	12:55 am eastern daylight time
Railroad:	Metro-North Railroad
Property Damage:	N/A
Injuries:	0
Fatalities:	1
Type of Accident:	Employee Fatality

The Accident

On March 10, 2014, at 12:55 a.m. eastern daylight time, a Metro-North Railroad (Metro-North) electrician was fatally struck by northbound train No. 897 near milepost 3.2 at Control Point 3 (CP 3) interlocking in Manhattan, New York. Three employees were attempting to re-energize tracks that had been out of service for maintenance. Two of the workers cleared the approaching train, but the third worker was struck by the train.

Figure 1. Accident site.

Metro-North had planned weekend track work at the CP 3 interlocking. The track department was replacing a switch connecting tracks 1 and 3. Starting Friday evening, March 7, 2014, an assistant track supervisor had received authority for track 1 and 3 from CP 2 to CP 3. This provided exclusive use of the tracks for maintenance and on-track protection from train movements.[1] The assistant track supervisor had also received authority for track 1 and track 3 from the south end of the CP 3 interlocking to a dividing line referred to as "the AB Split".[2] The assistant track supervisor held a job briefing Friday evening explaining the on-track protection he had obtained for the work. The track supervisors and the power department supervisor attended this job briefing.[3] The signal supervisor was briefed later when he arrived on scene. (See figure 2.)

[1] Roadway worker regulations require a clear understanding of the form of on-track protection provided for a work area.

[2] In order for maintenance employees to work on the tracks, they must have protection from trains. This protection is received from the rail traffic controller using either a Form M track authority or verbal authority that designates specific limits that trains will not be allowed to enter.

[3] Metro-North electricians working in the Power Department that maintain the third rail (as opposed to the overhead catenaries) are referred to as third rail [title] and third railman. In this report they will be designated as electricians.

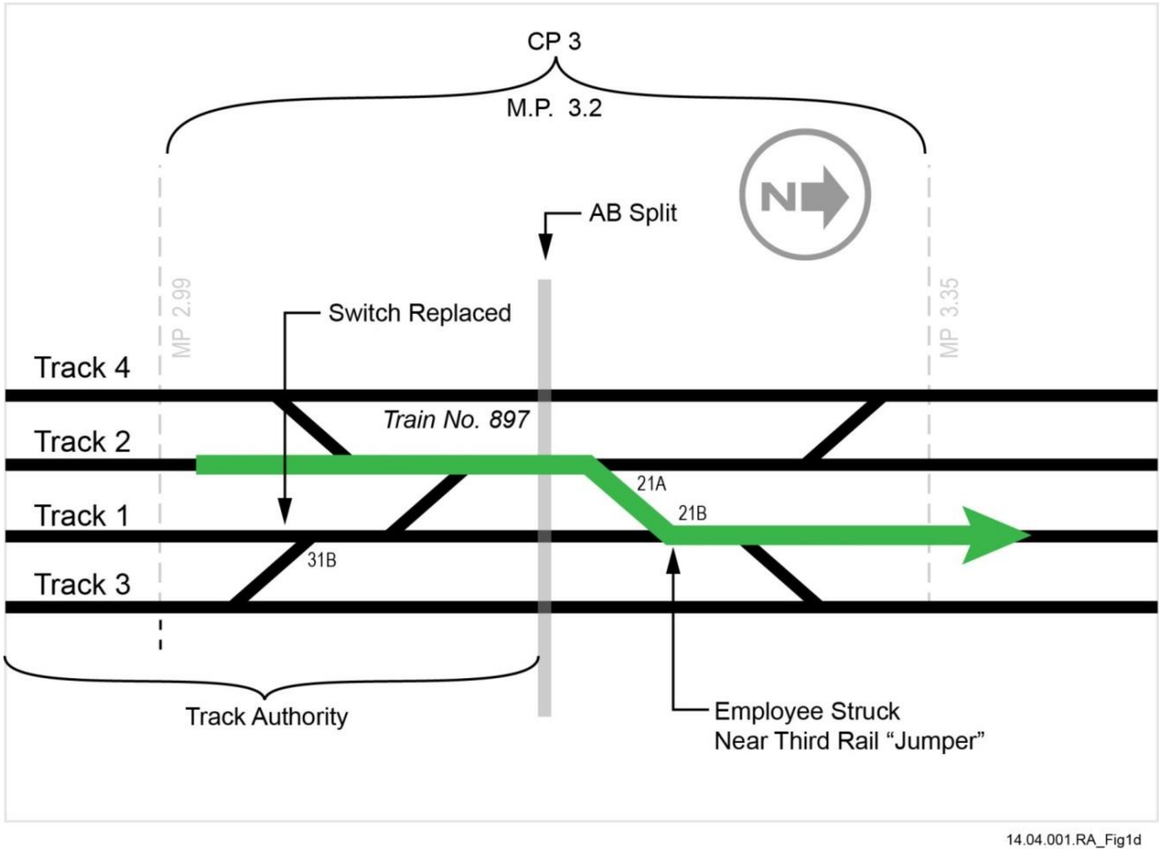

Figure 2. Diagram of CP 3 interlocking segments.

The AB Split was near the middle of the interlocking. (See figure 2.) The AB Split separated the signal system (but not the third rail) within the interlocking.[4] Using the AB Split as a limit for the on-track protection allowed the rail traffic controller (RTC) to block/lock switches at one end of the interlocking but still use the switches at the other end on the same track for train movements. Before starting the track work, the third rail was de-energized for track 1 within the CP 3 interlocking. This removed the power from track 1 through the interlocking and up to the 21B switch at the north end of the interlocking. The AB Split had no effect on the third rail. (See figure 2.) Using the AB Split as a limit of authority was normal practice for the signal and track department. However, during interviews with the NTSB, the electricians said they were less familiar with the location and use of the AB Split.

Although the authority ended at the AB Split, the power department supervisor stated that he believed the authority extended to the 21B switch (north of the AB Split) because of his knowledge that the third rail power would be de-energized within the CP 3 on track 1 to the 21B switch.

Just after midnight the day of the accident, the assistant track supervisor and the power department supervisor discussed by phone the work to be performed at CP 3. The power

[4] The third rail runs parallel and just outside the tracks and provides the electricity to the trains.

department supervisor said he recalled the assistant track supervisor telling him the authority was "the same thing that we had Friday night" - nothing had changed.

After his initial interview, the power department supervisor submitted written clarifications to his interview. In his clarifications he said that he did not think it was significant that the jumper (electrical connection) location was outside the authority limits. He believed it had been a standard practice for years that power department employees typically knew they were working on an unprotected (outside authority limits) track when working on the jumpers. He implied the employees should not have assumed there would be no train movements. However, the power department foreman and the electricians all clearly indicated that they were told track 1 was out of service throughout CP 3.

According to the power department foreman, the power department supervisor told him the authority was on track 1 through CP 3 and he needed his crew to reapply the jumper. The power department foreman wrote this on his Roadway Worker Briefing Form. However, this information incorrectly described the on-track protection as extending beyond the AB Split and did not include authority on the adjacent track 3.

During their interviews, the electricians were asked where they thought they were protected at CP 3. Each was interviewed separately but answered with the same phrase indicating that they understood they were protected on track 1 "at" CP 3, meaning their authority was within the entire area covered by CP 3.

The power department foreman and two electricians went to close the jumper adjacent to the 21B switch, which was outside the authority limits that were established Friday night by the assistant track supervisor.

1. 

Figure 29. Jumper inserted in receptacle and considered "closed."

The power department foreman and the two electricians had finished connecting the jumper and were removing an out-of-service tag when the train arrived. The two surviving employees said that they were not alarmed at first by the arrival of the train because they believed they had protection on track 1. As the train came closer (and the operator blew the horn) they realized the train was coming through the crossover and entering the track where they were standing. The workers yelled to each other and jumped toward track 3.

While operating about 40 mph, the engineer said that he saw three workers near the far end of the crossover he was entering. He blew the whistle as a warning and when he was halfway through the crossover he applied the emergency brakes. He witnessed two of the workers jump away from the tracks, but not the third. The third worker was struck and killed by the train.

In summary, the assistant track supervisor had authority on tracks 1 and 3 south of CP 3 and had authority on track 1 and track 3 within CP 3 interlocking, but only south of the AB Split. He relayed this information to the power department supervisor. The power department supervisor relayed an abbreviated and incorrect version of the authority limits and told the power department foreman that the authority was on track 1 at CP 3. The power department foreman relayed this information to the electricians on his workforce. All of the interviewed electricians stated they thought they had protection from train movements on track 1 at CP 3, when in fact they did not and they were working outside the authority limits.

The Investigation

Visibility and the weather were not factors in connection with the accident. The routing of the trains by the RTC around the authority limits was not a factor in this accident, because the struck worker was outside the limits. The actions of the train operator were not a factor in the accident; he blew the whistle and applied the brakes to try to stop the train.

The electricians involved with the accident had at least 9 years of experience each, and the power department supervisor had 30 years of experience. All of the employees had attended multiple training and educational classes. There were only minor issues found in a few of the discipline records. They were all familiar with the work and the work area.

Metro-North had rules and procedures in place to protect workers when performing maintenance on the tracks. The employees interviewed were all familiar with the different methods for protection from trains while working on or near the tracks.

Metro-North had a separate document for the roadway workers titled, *Roadway Worker Safety Manual* effective February 13, 2011. The proper method of performing a job briefing was provided by the following section:

RW 3 JOB BRIEFINGS

3-A A job briefing must be held prior to fouling a track, and any time that there is a change in on track safety. All Roadway Workers must participate in this job briefing.

3-B A job briefing must include:

1. The identification of the Roadway Worker in Charge.
2. The general plan and procedures for the work to be performed.
3. **The on-track protection methods that will be used including the means of on-track protection being provided and the limits of the protection.** [Emphasis added]
4. Definite work assignments.
5. The predetermined place of safety where roadway workers are to clear for trains or equipment.
6. The status of adjacent tracks, including the MAS and whether on-track protection is required for the work to be performed.

In this accident, the job briefing did not provide accurate information allowing the workers to be protected on the track from approaching trains. Metro-North had not ensured that the job briefings were being performed to the standard identified by the *Roadway Worker Safety Manual*.

Postaccident Actions

Metro-North Railroad

Metro-North instituted an employee Stand-Down on March 11, 2014, for over 340 employees. Part of the agenda covered the importance of daily job briefings and the use of the Safety Hotline to report safety issues.

Metro-North also issued the following prohibition on the use of the AB Split as a working limit when obtaining on-track protection:

> The use of an "A/B Split" or "B/C Split" as a "Working Limit" is not to be granted in the application of roadway worker protection within an interlocking for all Crafts other than qualified Signal Department Employees.[5]

Metro-North advised that they are developing a nonpunitive peer auditing process that includes union participation.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the miscommunication of the limits of on-track protection resulting from incomplete and inaccurate roadway worker job briefings. Contributing to the accident was use of

[5] March 20, 2014, Metro-North memorandum.

a reference point for on-track protection (the AB Split) that was poorly understood by some of the workers on the track.

For more details about this accident, visit www.ntsb.gov/investigations/dms.html and search for NTSB accident ID DCA14FR006.

Adopted: October 24, 2014

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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