National Transportation Safety Board

Railroad Accident Brief

New Jersey Transit Train Strikes Wall in Hoboken Terminal

Hoboken, New Jersey

The Accident

On September 29, 2016, about 8:38 a.m. eastern daylight time, New Jersey Transit (NJT) train 1614 failed to stop, overrode a bumping post at the end of track 5, and struck a wall of the Hoboken Terminal in Hoboken, New Jersey.[1] Train 1614 consisted of one controlling passenger car (cab car), three passenger cars, and one locomotive at the rear of the train. The train was traveling about 21 mph at the time of the accident.

About 250 passengers and 3 crewmembers (engineer, passenger car conductor, and assistant conductor) were on the train. One person on the passenger platform was struck by falling debris and died; 110 passengers and crewmembers were injured. Total damage to the train, track, and facility is estimated at $6 million. At the time of the accident, the sky was overcast, an 18-mph wind was coming from the northeast, and the temperature was 63˚F.

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

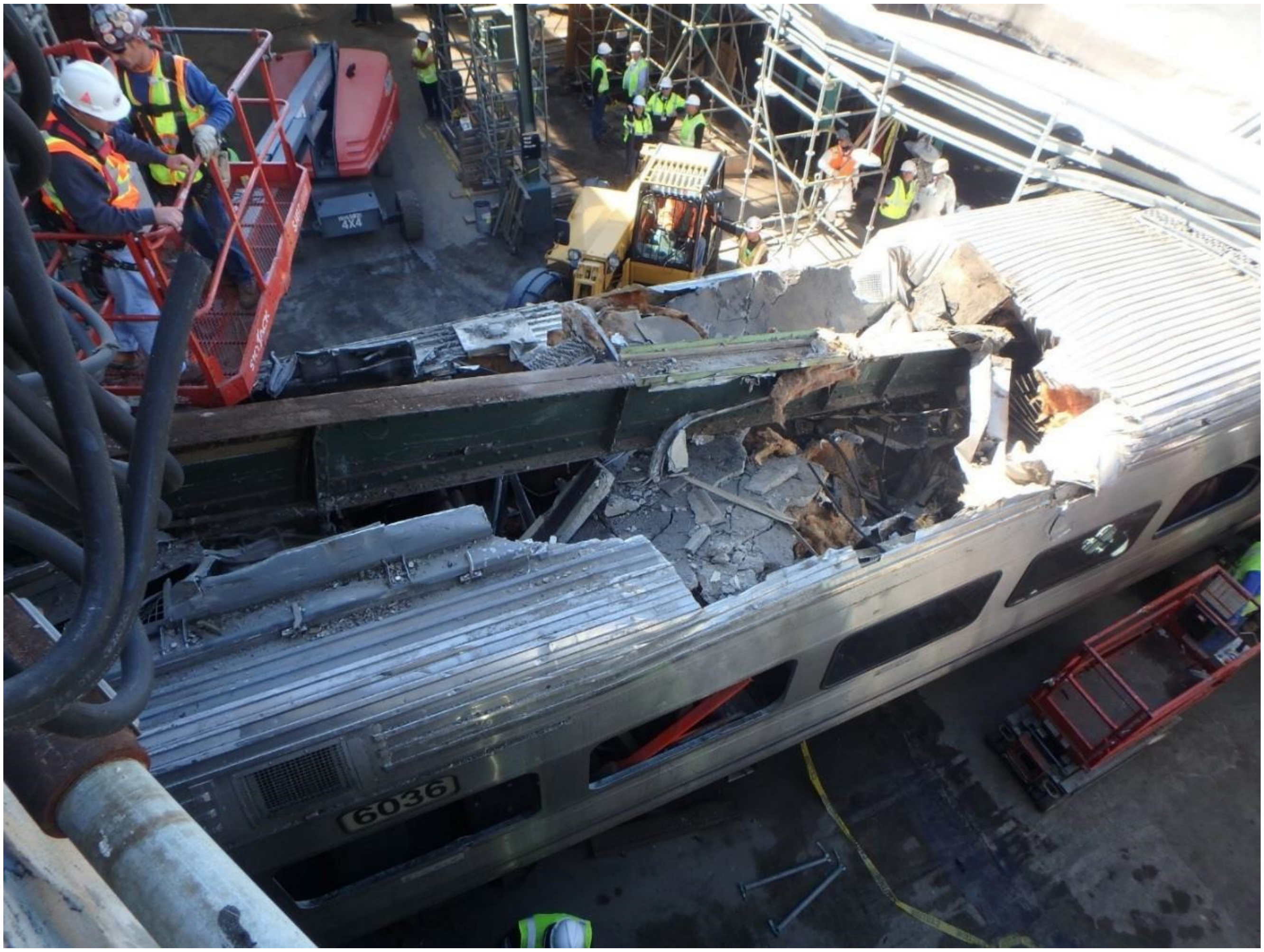

Figure. Damaged controlling cab car.

The Investigation

Train Crew

The engineer began his career with NJT in 1987 as a part-time ticket agent. He became an engineer in March 2000 and worked in that position until the accident. He was qualified to operate on the Pascack Valley Line (where the accident occurred) and all the other lines on the Hoboken Division. On the day of the accident, he went on duty at 6:46 a.m. in Spring Valley, New York. He told investigators that he felt fully rested upon arriving at work. He had been off work 2 days before the accident. In the days leading up to the accident, he said that he had received the amount of sleep he needed to wake up feeling rested. He said that his cell phone was off and stored in his personal backpack. He also said that there were no distractions either inside or outside of the operating compartment.

The engineer said that he had conducted the required brake tests on the train before leaving Spring Valley, and the train operated normally throughout the trip approaching the accident site.[2] He said that the cab alerter was operating properly, and there was clear visibility approaching the terminal.[3]

The engineer said that the train arrived on track 5, which is the normal arrival track for train 1614 at Hoboken Terminal. As the train approached the end of the terminal platform, he said that he sounded the horn, checked the speedometer, and started ringing the bell. He said that he looked at his watch and noticed the train was arriving about 6 minutes late. He said that the speedometer showed the train was moving at 10 mph as it entered the terminal. After the accident, he said that he woke up on the cab floor with no memory of the accident.

The conductor began his career with NJT in 2003 as an assistant conductor and worked as a ticket collector. At the time of the accident, he had worked about 11 1/2 years as a conductor and had worked every line on the Hoboken Division.

On the morning of the accident, the conductor said that he woke at 4:50 a.m. after sleeping 7 to 8 hours; he went on duty at 6:30 a.m. He worked the extra board, filling in on different assignments where needed; he had worked the 3 days before the accident.[4]

The conductor said he had worked with the engineer on other occasions. They spoke the morning of the accident, and the conductor said he did not notice anything unusual about the engineer's behavior. The preparation for departure was normal. That day, the train had four cars rather than the usual five, which resulted in people standing in the vestibules because of crowding; the conductor was unable to collect fares. The conductor did not notice anything unusual about the speed of the train as it approached the Hoboken Terminal, but he said that his focus was on the crowded conditions. After the accident, the conductor helped evacuate the train. He walked through the train to ensure that all passengers had exited.

The assistant conductor said that he had worked as an NJT brakeman and as a conductor for 20 years. On the morning of the accident, he said that he had woke at 5:15 a.m. and "felt fine" after going to bed at 10:00 p.m. the previous night. He went on duty at 6:31 a.m. and arrived at work a few minutes before his shift was to start. He walked with the engineer to the train; they had a casual conversation. The assistant conductor did not notice anything unusual about the engineer's behavior.

During the trip, the assistant conductor was responsible for the third and fourth passenger cars. He told investigators that the trip was routine, and the engineer had operated the train properly at each station stop. As the train approached Hoboken Terminal, the assistant conductor was in the

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[2] Refer to Title 49 *Code of Federal Regulations* (*CFR*) 232.205 for information on a Class I air brake test.

[3] An *alerter* is a safety device required by 49 *CFR* 229.140 that is installed in the locomotive cab to promote engineer attentiveness by monitoring some engineer-induced control activities. If the engineer's control activity is not detected in a predetermined time, both audible and visual alarms are activated to prompt a response. Failure to acknowledge the alerter through a manual reset provision results in a penalty brake application that brings the locomotive (or the train) to a stop.

[4] An *extra board employee* does not have a regular job assignment, instead serving as a substitute when a regularly assigned employee is not available. Train and engine employees who work in yards, local freight service, and passenger and commuter operations have jobs with regular start-stop work times.

fourth car preparing to make an announcement over the public-address system. After the train's fourth car crossed over the switches, the assistant conductor noticed the train was not slowing as it normally would; he sensed the train was beginning to accelerate. He decided to try to apply the emergency brakes, which required him to move through a crowd of passengers. Just before he reached the emergency brake switch, he thought he heard the emergency brakes apply; he then felt the collision.

After the collision, he helped to evacuate the passengers. He also got off the train and re-entered at the first car, making his way to the operating compartment where he found the "unconscious" engineer on the floor under some debris.

Toxicology

Quest Laboratory conducted FRA-mandated postaccident toxicology for the engineer, conductor, and assistant conductor in accordance with federal regulations.[5] The results of the toxicology tests for the conductor and assistant conductor were negative for tested-for drugs and alcohol. The engineer's testing was negative for alcohol and all tested-for drugs, but positive for the pain medication oxycodone and its metabolite oxymorphone. The investigation determined that these medications were administered during hospital treatment which occurred before the test. Additionally, the NJT medical review officer reviewed the case and downgraded the results to negative.

Recorders

The video showed the train operating over dozens of crossings, and it recorded the bell and horn sequence as the train approached each grade crossing. The data showed that the engineer did not operate in accordance with train horn regulations at several crossings.[6]

The NJT train's forward-facing audio/video recording showed the cab car colliding with and overriding the bumping post at the end of the track 5 platform. A large flash was visible as the car collided with the panel at the end of the track. About 1 minute before the collision, the forward-facing audio/video recorder recorded one sounding of the train's horn while the train was in the yard leading up to the station. Shortly afterward, the train's bell began sounding, and it continued until the end of the recording.

Locomotive event recorder data indicated that about 38 seconds before the collision, the throttle increased from idle to the number 4 position while the train was traveling about 8 mph. The train speed began to increase, and the speed reached about 21 mph. Just before the collision, the event recorder indicated that the throttle position went from position 4 to idle. Engineer-induced emergency braking occurred less than 1 second before the collision with the

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[5] Quest Laboratory tested specimens for alcohol, amphetamines, barbiturates, benzodiazepines, cannabinoids, cocaine, MDMA/MDA, methadone, opiates/opioids, phencyclidine, tramadol, brompheniramine, chlorpheniramine, diphenhydramine, doxylamine, and pheniramine.

[6] In accordance with the Train Horn Rule (49 *CFR* Part 222), engineers must begin to sound train horns at least 15 seconds, and no more than 20 seconds, in advance of all public grade crossings. Train horns must be sounded in a standardized pattern of two long, one short, and one long blasts. The pattern must be either repeated or prolonged until either the lead locomotive or the lead cab car occupies the grade crossing.

bumping post. Although the authorized speed was 10 mph, the event recorder showed the train speed was about 21 mph at the time of the collision.

Medical Factors

The engineer told investigators that he had not been taking any medications. He said that he had never been diagnosed with either obstructive sleep apnea (OSA) or any other sleep disorder. He said that he needed about 7 hours of sleep to feel rested and he would take a nap "not every day, but sometimes" between assignments in the breakroom. He stated that his quality of sleep was "fine," and he would wake up feeling "fine."

The engineer did not recall ever having a blackout. His last required physical examination at NJT was about 3 months before the accident. He was medically certified for service.

Following the accident, the engineer underwent a home sleep study on October 21, 2016. A board-certified pulmonary and sleep medicine physician evaluated the engineer. The engineer's height was 6 feet, he weighed 322 pounds, and had a body mass index of 43.67 kg/m^2.[7] Additionally, he scored 7 of 24 points on the Epworth sleepiness scale (indicating a normal amount of sleepiness). Testing results included an apnea-hypopnea index (AHI) of 89.6 episodes per hour with an average oxygen saturation during testing of 84 percent, dropping to as low as 53 percent.[8] The sleep medicine specialist diagnosed him with severe OSA with severe sleep fragmentation; the specialist prescribed the use of a continuous positive airway pressure (CPAP) machine.[9]

OSA is a chronic disease in which patients experience episodes of airway obstruction while sleeping. During each episode, the person stops breathing for a period causing the blood oxygen levels to drop and the blood carbon dioxide levels to rise. When the blood carbon dioxide level gets too high, the brain detects it, and the person either arouses or awakens to breathe. The result is fragmented sleep and subsequent daytime sleepiness and fatigue. Risk factors for OSA include: male gender, age, obesity, hypertension, large neck circumference (greater than 16 inches in women and 17 inches in men), a waist-to-hip circumference ratio of greater than 1 for men and 0.85 for women, and snoring.[10]

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[7] According to the National Institute of Health, a body mass index of more than 40 kg/m^2 indicates severe or morbid obesity and increases the risk of type II diabetes, high blood pressure, cardiovascular disease, and OSA.

[8] 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 adds the frequency of both types of episodes. An AHI of less than 5 is considered normal. An AHI of 5 to 15 is mild sleep apnea; 15 to 30 is moderate sleep apnea, and more than 30 events per hour is considered severe sleep apnea.

[9] *CPAP* is a treatment for OSA that uses a machine to generate positive air pressure that is delivered though a mask the covers the nose or nose and mouth to keep the airways open during sleep.

[10] (a) P.E. Peppard, and others, "Increased Prevalence of Sleep-Disordered Breathing in Adults," *American Journal of Epidemiology* 177, no. 9 (2013): 1006-1014; (b) J.C. Seidell, "Waist Circumference and Waist/Hip Ratio in Relation to All-Cause Mortality, Cancer and Sleep Apnea," *European Journal of Clinical Nutrition* 64, no. 1 (2010): 35-41; (c) T. Young and others, Sleep Heart Health Study Research Group, "Predictors of Sleep-Disordered Breathing in Community-Dwelling Adults: the Sleep Health Study," *Archives of Internal Medicine* (now *JAMA Internal Medicine*) 162, no. 8 (2002): 893-900; (d) L.G. Olson and others, "A Community Study of Snoring and Sleep-Disordered Breathing Prevalence," *American Journal of Respiratory and Critical Care Medicine* 152, no. 2

NJT OSA Screening

FRA does not mandate OSA screening, however NJT screens safety-sensitive personnel. During physical examinations, a NJT physician was required to complete a NJT form titled "Epworth Sleepiness Scale" which records weight, height, body mass index, and neck circumference, and poses a number of subjective questions to gauge how likely the employee is to doze off or fall asleep during the day. The physicians were provided with the form, as well as the 2006 Tri-Medical Society Task Force screening and referral recommendations, which provided guidance on determining whether to refer an employee for a sleep study. In interpreting the information on the Epworth Sleepiness Scale, the physicians did not rely only on one factor, but used a combination of discretion and the 2006 recommendations to make that determination. The investigation determined that the engineer, conductor, and assistant conductor all met NJT screening criteria for referral for definitive OSA testing but had not been referred. Furthermore, the NJT medical department was unable to locate the engineer's most recent OSA screening form.

Since the accident, NJT has started a program to ensure OSA screening forms are completed, centrally reviewed, and that safety-sensitive employees meeting referral criteria are removed from service until appropriately tested and successfully treated.

Signal and Train Control

Investigators inspected the affected signal equipment and physical layout of train 1614's interlocking route from the automatic signal M06T3 milepost (MP) 0.6 to the train shed track 5 signal at MP 0.0.[11] The signal at the end of track 5 and track circuit A40B were not inspected because of damage to the signal, track, and terminal. The forward-facing video verified that the signal at the end of track 5 was illuminated, and the aspect was red. Track circuits were inspected, verified, and shunted sequentially to simulate a train taking the same route as train 1614. All signal locations were inspected and verified for proper operation. The signal circuits were free of grounds, and all signal lamp units were working as intended with proper voltage levels. The signal route and signal aspect sequence testing were performed between the automatic signal M06T3 at MP 0.6 and terminal interlocking signal 26 E. Investigators found no deficiencies in either the signal aspect or cab signal code rate. The signal preview and signal spacing were of sufficient length to comply with the operating rules. Investigators found no defects in the inspected units. The NJT maintenance, inspections, and tests records for the signal system were in accordance with the Federal Railroad Administration (FRA) requirements. The signal and train control system functioned as designed.

Positive Train Control

A positive train control (PTC) system had not been implemented at the time of the accident. NJT planned to implement a PTC system called the Advanced Speed Enforcement System, which is second generation (ASES II). The existing cab signal system (CSS) will continue to provide

(1995): 711-716; (e) T. Young and others, "Risk Factors for Obstructive Sleep Apnea in Adults," *Journal of the American Medical Association* 291, no. 16 (2004): 2013-2016.

[11] The train shed is the signal location at the entrance to the covered portion of the track leading to the Hoboken Terminal.

train separation and signal speed enforcement while ASES II complements the CSS and provides other required PTC functions. The two systems—CSS and ASES II—are functionally independent, although both do report status and transfer certain data.

FRA regulations permit the exclusion of certain "mainline tracks" from PTC requirements. NJT designated certain line segments in its January 2016 PTC Implementation Plan as other than main line track. NJT included this terminal interlocking at Hoboken as a designated exemption from the PTC requirements. This terminal included 20 track terminus points (17 passenger platform tracks, extending from each end of track, each with an eastbound fixed inoperative stop signal; and three additional tracks at the southern limits) to the eastbound home signals at the terminal.

Mechanical

Investigators reviewed maintenance records for the locomotive and passenger car equipment and found that NJT's inspection and maintenance program was comprehensive and met the FRA's daily and periodic inspection requirements.[12] On September 28, 2016, the controlling cab car, 6036, passed an FRA-required pretrip cab signal inspection. The following day, qualified inspectors completed an FRA Class I air brake test on train 1614 and found no exceptions. Additionally, an FRA-required running air brake test was performed by the engineer with no exceptions.

Investigators examined the controlling cab car to determine whether the brake control system, throttle, and other systems could be repaired to complete the postaccident testing. The cab car electrical communication network necessary for brake, signal, and propulsion control was destroyed in the accident; the functional testing of key controlling components would be necessary to assess the mechanical condition of the train prior to the accident. The accident damage to the cab car's air brake system was minor and was repaired for testing. A friction brake test was completed using the rear locomotive to apply the brakes; the brakes functioned as designed.

The equipment from cab car 6036 was sent to the manufacturer for a comprehensive qualification test of components according to the manufacturer's test procedures. The NTSB investigators witnessed the testing. The results of the testing showed that all components functioned as designed.

Track

The tracks in the accident area consisted primarily of four main tracks, designated as tracks 1 through 4, that pass through the Bergen Tunnels and into the Hoboken East End Interlocking. Between the East End Interlocking and the Terminal Interlocking on the NJT Morristown Line, six main tracks were present; these six main tracks were designated as: 1, 2, 3, 4-main, 6-main, and 122. Approaching the terminal, main tracks 1 through 3 were adjacent, and the other three main tracks diverged southward. There were 19 tracks at the Hoboken Terminal.

[12] These requirements are specified in 49 *CFR* Part 229, Railroad Equipment Safety Standards, and 49 *CFR* Part 238, Passenger Equipment Safety Standards.

Entering the terminal, at MP 0.39, the track is designated as FRA Class 1 track, which allows for a maximum operating speed of 15 mph for passenger trains. The NJT timetable further restricted speeds to 10 mph for all trains inside the train shed. The train shed started about 600 feet before the end of the tracks. NTSB investigators did not observe any track conditions that would have affected the operation of the accident train.

Bumping Post

The bumping post at the end of Hoboken Terminal's track 5 was installed in 1908.[13] Its purpose was to help control unintended equipment movement. The bumping post was constructed of steel with thicknesses ranging from 0.5 inch to 0.75 inch. The base of the bumping post was set in concrete. Generally, the visible portion of the bumping post measured 60 inches high and 24 inches wide; and the depth was about 22 inches at the top angling down to 60 inches at the concrete slab base. A 24-inch by 16-inch striking plate was mounted about 42 inches above the running surface of the rail.

Train 1614 was traveling at 21 mph when it struck and destroyed the bumping post at the end of track 5. The bumping post was displaced backward 65 inches toward the station platform. The concrete slab moved 40 inches toward the platform. The base of the bumping post tore from the concrete slab, canted about 55 degrees, and moved 25 inches toward the platform. The strike plate and its mounting post were found beneath the front truck of the lead controlling cab car.

Emergency Response

The NJT police department has offices in the Hoboken Terminal. The emergency response to the accident began immediately. Firefighters and police officers ensured power was removed from the track area, stabilized the scene, and evacuated the train and the terminal. The last passenger was evacuated within 1 hour of the accident.

Probable Cause

The National Transportation Safety Board determined that the probable cause of the Hoboken, New Jersey, accident was the failure of New Jersey Transit train 1614's engineer to stop the train after entering Hoboken Terminal due to the engineer's fatigue resulting from his undiagnosed severe obstructive sleep apnea. Contributing to the accident was New Jersey Transit's failure to follow its internal obstructive sleep apnea screening guidance and refer at-risk safety-sensitive personnel for definitive obstructive sleep apnea testing and treatment. Further contributing to the accident was the Federal Railroad Administration's failure to require railroads to medically screen employees in safety-sensitive positions for obstructive sleep apnea and other sleep disorders. Also contributing to the accident was the lack of either a device or safety system that could have intervened to stop the train before the collision.

[13] *A bumping post* is a braced post, a block, or an obstruction placed at the end of either a stub or a spur track to halt car movement and prevent cars from going off the rails.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Chairman

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Member

Adopted: February 6, 2018

For more details about this accident, visit www.ntsb.gov/investigations/dms.html and search for NTSB accident number DCA16MR011.

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. (Title 49 *United States Code* (*USC*) Section 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." Title 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 *USC* 1154(b).
