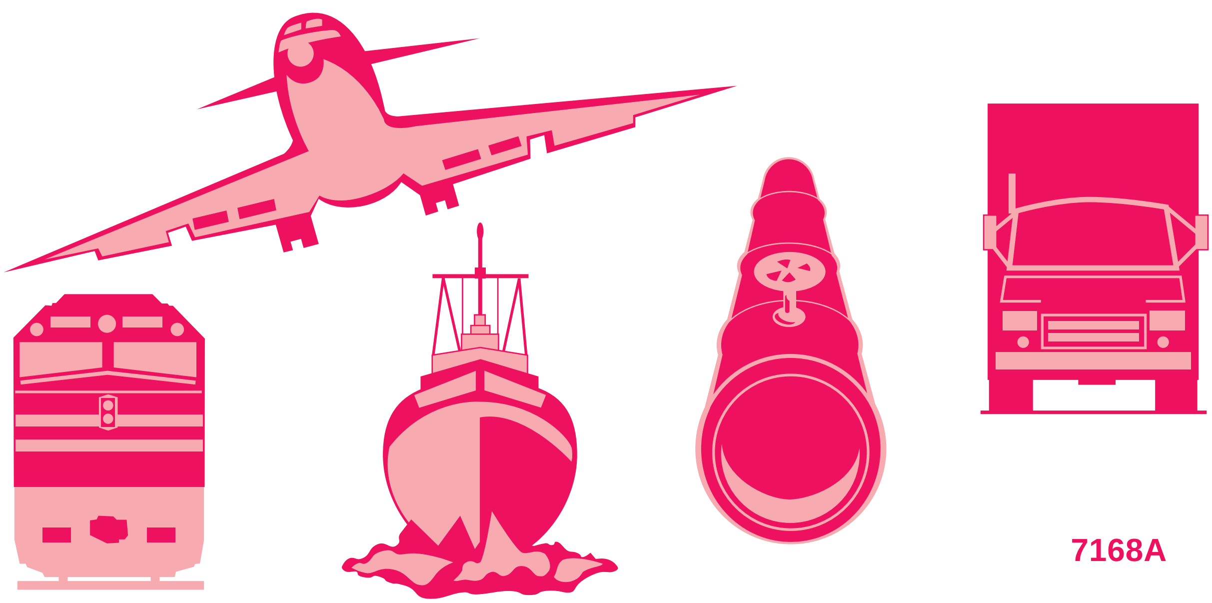
PB2002-916301
NTSB/RAR-02/01

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

COLLISION OF NATIONAL RAILROAD PASSENGER CORPORATION (AMTRAK) TRAIN 59 WITH A LOADED TRUCK-SEMITRAILER COMBINATION AT A HIGHWAY/RAIL GRADE CROSSING IN BOURBONNAIS, ILLINOIS, MARCH 15, 1999



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THIS CORRECTION IS *INCLUDED*
IN THIS VERSION OF THE PUBLISHED REPORT:

RAILROAD ACCIDENT REPORT
NTSB/RAR-02/01 (PB2002-916301)

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- Page 29 has been updated to include coach car #34089. (11 Sep 2002)
  Coach car #34089 was excluded from the original printed version. Car numbers were also added for the sleeping car (32035) and diner car (38020).

Railroad Accident Report

Collision of National Railroad Passenger Corporation (Amtrak) Train 59 With a Loaded Truck-Semitrailer Combination at a Highway/Rail Grade Crossing in Bourbonnais, Illinois, March 15, 1999

NTSB/RAR-02/01
PB2002-916301
Notation 7168A
Adopted February 5, 2002

National Transportation Safety Board
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

National Transportation Safety Board. 2002. ***Collision of National Railroad Passenger Corporation (Amtrak) Train 59 With a Loaded Truck-Semitrailer Combination at a Highway/Rail Grade Crossing in Bourbonnais, Illinois, March 15, 1999.*** **Railroad Accident Report NTSB/RAR-02/01. Washington, DC.**

Abstract: About 9:47 p.m. on March 15, 1999, National Railroad Passenger Corporation (Amtrak) train 59, with 207 passengers and 21 Amtrak or other railroad employees on board and operating on Illinois Central Railroad (IC) main line tracks, struck and destroyed the loaded trailer of a tractor-semitrailer combination that was traversing the McKnight Road grade crossing in Bourbonnais, Illinois. Both locomotives and 11 of the 14 cars in the Amtrak consist derailed. The derailed Amtrak cars struck 2 of 10 freight cars that were standing on an adjacent siding. The accident resulted in 11 deaths and 122 people being transported to local hospitals. Total Amtrak equipment damages were estimated at $14 million, and damages to track and associated structures were estimated to be about $295,000.

The safety issues discussed in this report are as follows: truckdriver performance, emergency response, and signal system performance.

As a result of this investigation, the Safety Board makes safety recommendations to the U.S. Department of Transportation, the Federal Railroad Administration, all class I and regional railroads, Amtrak, the International Association of Fire Fighters, and the International Association of Fire Chiefs.

Contents

Executive Summary

About 9:47 p.m. on March 15, 1999, National Railroad Passenger Corporation (Amtrak) train 59, with 207 passengers and 21 Amtrak or other railroad employees on board and operating on Illinois Central Railroad (IC) main line tracks, struck and destroyed the loaded trailer of a tractor-semitrailer combination that was traversing the McKnight Road grade crossing in Bourbonnais, Illinois. Both locomotives and 11 of the 14 cars in the Amtrak consist derailed. The derailed Amtrak cars struck 2 of 10 freight cars that were standing on an adjacent siding. The accident resulted in 11 deaths and 122 people being transported to local hospitals. Total Amtrak equipment damages were estimated at $14 million, and damages to track and associated structures were estimated to be about $295,000.

The National Transportation Safety Board determines that the probable cause of the collision between Amtrak train 59 and a truck tractor-semitrailer combination vehicle at the McKnight Road grade crossing in Bourbonnais, Illinois, was the truckdriver's inappropriate response to the grade crossing warning devices and his judgment, likely impaired by fatigue, that he could cross the tracks before the arrival of the train. Contributing to the accident was Melco Tranfer, Inc.'s failure to provide driver oversight sufficient to detect or prevent driver fatigue as a result of excessive driving or on-duty periods.

The safety issues identified during this investigation are as follows:

- Truckdriver performance;
- Emergency response; and
- Signal system performance.

As a result of this investigation, the Safety Board makes safety recommendations to the U.S. Department of Transportation, the Federal Railroad Administration, all class I and regional railroads, Amtrak, the International Association of Fire Fighters, and the International Association of Fire Chiefs.

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Factual Information

Synopsis

About 9:47 p.m. on March 15, 1999, National Railroad Passenger Corporation (Amtrak) train 59, with 207 passengers and 21 Amtrak or other railroad employees on board and operating on Illinois Central Railroad (IC) main line tracks, struck and destroyed the loaded trailer of a tractor-semitrailer combination that was traversing the McKnight Road grade crossing in Bourbonnais, Illinois. (See figure 1.) Both locomotives and 11 of the 14 cars in the Amtrak consist derailed. The derailed Amtrak cars struck 2 of 10 freight cars that were standing on an adjacent siding. The accident resulted in 11 deaths and 122 people being transported to local hospitals. Total Amtrak equipment damages were estimated at $14 million, and damages to track and associated structures were estimated to be about $295,000.

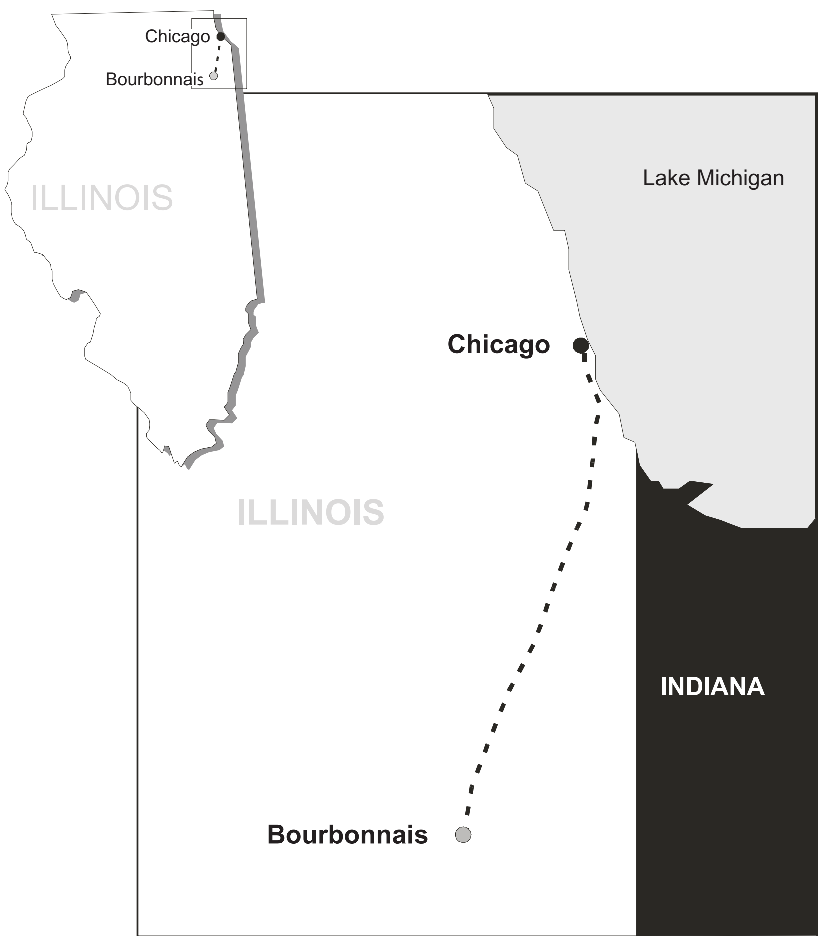

Figure 1. Accident Location.

Accident Narrative

Shortly after 8:30 p.m. on March 15, 1999, the driver of the truck involved in this accident picked up his truck tractor semitrailer at Melco Transfer, Inc., (Melco) in Peotone, Illinois. The driver was operating the vehicle under a 60-day probationary license that had been issued in January 1999 after his commercial driver's license (CDL) was suspended for 90 days because of three traffic citations within a 1-year period.[1] He drove the truck to the Birmingham Steel plant in Bourbonnais, Illinois. At the plant, the semitrailer was loaded with 6 bundles of 60-foot-long, 3/4-inch-diameter steel reinforcing rods (rebar). When the loading of the flatbed semitrailer was completed, the driver secured the load and drove the truck over weigh scales. The vehicle gross weight was registered at 74,880 pounds. The truck left the plant compound, turned right onto McKnight Road, and traveled eastward about 650 feet to the highway/railroad grade crossing. The grade crossing was equipped with train-activated flashing lights, bells, and automatic gate arms.

Amtrak train 59, the *City of New Orleans*, originated in Chicago, Illinois, and was bound for New Orleans, Louisiana. The crew reported for duty at 7:15 p.m. Before the train departed, the engineer performed an air brake test. No exceptions were taken. The engineer also stated that he checked the headlight and ditch lights and that they were working properly. The train departed Chicago at 8:03 p.m. The engineer stated that during the trip, the ditch lights oscillated properly at the crossings when he activated the train horn. He also said that the train brakes responded properly each time they were used. At the train's first scheduled stop, in Homewood, Illinois, no passengers left the train, while an unknown number of passengers boarded. The train departed Homewood at 9:27 p.m.

The accident truckdriver stated that the crossing lights started flashing when he was "right on top of the track." He said he did not notice the position of the crossing gates. The crossing lights had activated on the approach of Amtrak train 59. The truckdriver said he was concerned about braking hard because decelerating too quickly could cause the load on the semitrailer to shift forward and strike the tractor cab. He said he believed that if he attempted to brake moderately to avoid a load shift, he might bring the truck to a halt on the crossing and in the path of the oncoming train. He said he was thus momentarily undecided about whether he should attempt to stop or continue across the crossing, but in the end he "just floored it." He stated that as he traversed the crossing, he looked right and left and saw that the light of the train "wasn't too far down the tracks then." The truckdriver said he believed his vehicle was in sixth gear and traveling about 20 mph at the time of the collision.

Meanwhile, an individual who stated that he was in the Bourbonnais area looking for a used car had mistaken the Birmingham Steel Company parking lot for a used car dealership. Realizing his mistake, he turned around in the parking lot and attempted to reenter McKnight Road. He said that after waiting for a truck and a passenger car to pass, he turned right onto McKnight Road. He said that the car in front of his was stopped because the lights had begun to flash, and he stopped behind it. He stated that at that time,

[1] See the "Personnel Information" section of this report for more information.

the truck "was approaching the rail" and that "when the… [gates] were coming down, the trailer was already almost on top of the track and, yes, contact was made with one crossing gate." He said the gate struck the right side of the trailer about a third of the way back and that he saw a piece of the gate break off. The witness also stated that the truck moved from the right-hand lane toward the middle of the roadway. He estimated that the truck was traveling about 7 mph at the time.

The train 59 engineer, who was the only person in the locomotive cab at the time, stated that he saw the truck slowly moving over the crossing, and he sounded the train horn to warn the truckdriver. He said that when he realized that the truck would not clear the crossing before the train arrived, he initiated emergency braking.[2] Traveling at 79 mph, the train did not have sufficient distance to stop and struck the left rear of the semitrailer. (See figure 2.) The time was about 9:47 p.m.

Figure 2. Aerial view of crash scene.

The conductor stated that he was walking through the coach behind the diner when he heard the train's brakes apply and felt a bump. He believed that the train accelerated, and then the car rolled over on its side. The conductor stated that at this point he helped a passenger remove a window and climbed outside; once outside, he communicated by radio with the assistant conductor and the locomotive engineer. When the engineer said

[2] According to the locomotive event recorder, the engineer applied the train brakes, but he did not activate emergency braking.

that he was trapped in the locomotive, the assistant conductor said he would go help the engineer. The conductor remained at the coach and helped passengers evacuate.

At the time of the accident, a crane operator on duty at Simms Metal America, which is west of and adjacent to the Birmingham Steel plant, had a view of the accident crossing and the approach. According to a postaccident IC survey, the crane was between 1,600 and 1,800 feet from the crossing, depending on its position along its track. The crane operator said he was swinging the crane to the northeast when he noticed the grade crossing lights begin to flash. He looked to the north and, over the tops of rail cars that were parked on a siding parallel to the main line, he could see the headlight of a moving southbound train. By his estimate, he could see the train about 1/2 mile from the crossing. He then made a lift of scrap material and deposited it in a bucket for use by the steel mill. He stated that it takes between 15 to 20 seconds to pick up material, put it in the bucket, and turn around.[3] He said that when he looked back toward the crossing, he saw the impact of the train and the truck. He did not remember seeing the crossing gates, nor did he remember seeing any vehicles at the crossing before the crash.

A truckdriver who was in the steel plant parking lot stated that he first saw the accident-involved truck through his rearview mirror as it was rolling across the Birmingham Steel plant's scale on its way out of the parking lot. The accident truck proceeded directly to the westernmost parking lot exit and turned right onto McKnight Road. As the accident truck came parallel to the parked truck's position and entered the roadway, the witness was putting a tarpaulin on his load in the parking lot. The witness watched the progress of the accident truck because he was interested in the fact that it carried an oversized load of steel. He stated that he heard the accident truck's jake brake as it rolled by him on the roadway.[4] He also said he saw the truck's brake lights illuminate for a few seconds, after which the truck proceeded across the tracks with its left tires slightly beyond the centerline of the roadway. This witness stated that he did not notice flashing lights as the truck proceeded into the intersection, and that the gates were up. He indicated that the only time he saw the lights illuminated was after the accident. He also did not notice any other vehicles on McKnight Road before the accident.

A security guard employed in the scale house of the steel plant knew the accident truckdriver, and spoke briefly with him shortly before the accident. He indicated that the truckdriver's behavior and conversation seemed normal, that there was no sign of drowsiness or other impairment. The security guard looked toward the crossing when he heard the train horn, but his view was blocked by trucks in the steel plant parking lot. He stated that he saw the crossing lights begin to flash, and that roughly 5 seconds later the train arrived at the crossing.

[3] Safety Board tests verified the accuracy of this estimate.

[4] A *jake brake* is a compression release braking system, supplemental to the main air brakes, that uses the engine to provide braking power for the vehicle. When the jake brake is turned on and the driver removes his foot from the accelerator pedal, the jake brake immediately activates. In some vehicles, the activation of the jake brake will cause the activation of the brake lights.

The security guard's wife was visiting the scale house at this time. She stated that she noticed the crossing lights were flashing, and she could see the taillights of the truck. At that time, she believed the truck cab was past the crossing, but she was unable to determine the position of the taillights. (See figure 3 for positions of all witnesses at the time of the collision.)

Figure 3. Aerial view of crash scene showing locations of witnesses to accident: 1. crane operator; 2. two people in scale house, 3. truckdriver affixing tarp to his load; and 4. motorist behind accident truck.

A motorist driving south on Illinois Route 50 adjacent and parallel to the IC tracks about the time of the accident said that as he drove down the highway, he noticed a southbound Amtrak passenger train to his right. He said as he approached the intersection of Route 50 and McKnight Road, he looked west and saw an Amtrak passenger car stopped and blocking the crossing. He said he drove to the crossing, where he observed that an accident had taken place. He said he saw and approached a person walking near the accident truck. When this person identified himself as the truckdriver, the motorist asked him if he was injured, and the truckdriver replied that he was not, except for a cut on his hand. The motorist said that he asked the truckdriver if he had been stuck on the tracks, and the truckdriver said that he had not been stuck, that he had seen the signal lights and thought that he could get across the tracks. He quoted the truckdriver as saying, “I didn't think the train was moving that fast.”

Emergency Response

At 9:48 p.m., the Kankakee County Sheriff's Police 911 communications desk received the initial request for emergency assistance via telephone from the Birmingham Steel security office.[5] Shortly thereafter, a second call came from the Birmingham Steel Company; this was followed by a number of additional calls from various sources. While the initial call was in progress, the 911 communications dispatch center dispatched units of the Bourbonnais Fire Protection District to the accident scene and requested an ambulance response.

About 9:51 p.m., an officer of the Bourbonnais Police Department, who had overheard the initial radio notification while on routine patrol, arrived at the accident scene via the unpaved roadway to the west of the tracks. At about the same time, a Bradley Police Department officer arrived on the east side of the tracks. The Bourbonnais police officer reported that a locomotive was on fire and that a number of Amtrak passenger cars had derailed. He observed that the fire was growing, and that it was working its way toward the rear of the locomotive, where a sleeper car (No. 32035) had come to rest. He radioed for additional emergency response support, and he and the Bradley police officer began helping to evacuate the passenger cars. Within a short time, more police units responded, and officers began evacuating passengers wherever they could.

According to the Kankakee County Sheriff's Department, the Kankakee County disaster plan was put into effect about the time the first responding police unit arrived on the scene. The Bourbonnais Police Department established an initial staging area on the unpaved roadway on the west side of the tracks, in the area adjacent to the wreckage pileup. The evacuated passengers and traincrew assembled in this area, where responding ambulances later arrived.

The chief of the Bourbonnais Fire Protection District received the call to dispatch while on scene at a previous response call. While en route to the accident scene, he overheard radio transmissions from responders already at the scene. As incident commander, he radioed a "box alarm" to summon emergency equipment and personnel. He arrived at the accident scene at about 9:52 p.m. Upon arrival, he conducted an initial assessment of the situation and identified the locomotive fire and the necessity for passenger evacuation. About 10:05 p.m., he placed a radio call for additional mutual aid emergency response support. The chief then established a fire department field command post at the initial staging area.[6]

In interviews with the Safety Board, emergency responders indicated that the immediate focus of the response was the extrication of the trapped and injured passengers and traincrew. Relatively early during the response, emergency responders telephoned Amtrak's National Operations Center in Wilmington, Delaware, to learn how many

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[5] Information on emergency response is based on official transcripts from Kankakee County Sheriff Radio and Fire Band transmissions, interviews by Safety Board investigators, and documentation submitted.

[6] Although there is no record of a radio transmission to this effect, incident command participants reported to the Safety Board that the establishment of the command post was understood.

passengers rescuers could expect to find. At this time, Amtrak responded that the train could be carrying as many as 400 passengers. When Amtrak management arrived on scene however, they determined from the contents of the conductor's ticket pouch that the passenger count was 196; this passenger tally was not considered firm on the following morning. Several days after the accident, Amtrak and local authorities determined that the passenger count was 198. Another several days passed before Amtrak could produce a complete list of passenger names. Subsequent research has shown the correct passenger count to be 207.

About 9:53 p.m., the first ambulances arrived at the scene. About 9:59 p.m., Bourbonnais Fire Protection District Squad 62 arrived at the scene. The squad 62 truck had a water capacity of 500 gallons dispersed through 1 3/4-inch hose lines. The truck was also equipped with 5-gallon fire suppression foam containers.[7] Firefighters then began hand-line water and foam application on the burning locomotive, but they were unable to put out the fire before exhausting their water supply.

About 10:00 p.m., Bourbonnais Fire Protection District Engine 61, a pumper truck carrying about 2,000 feet of 5-inch hose line, arrived at a water hydrant about 2,600 feet from the site of the fire. Firefighters laid out the full length of the hose on their truck, then went to the accident scene. A second pumper truck connected the additional hose line needed to reach the fire scene.

When the first Bourbonnais Fire Protection District personnel arrived at the accident scene, they saw that some 30 to 35 employees of Birmingham Steel had responded to the scene and had begun the rescue effort. These steel plant employees had cut a hole in the chain-link fence separating the wreckage site from the steel plant's property and had brought a number of hand-held fire extinguishers and ladders from the plant to combat the flames. While some of the steel plant employees applied the fire extinguishers to the flames, others entered some of the damaged passenger cars to extricate entrapped passengers. These efforts were continued for about 45 minutes, when the steel plant employees were relieved by Bourbonnais Fire Protection District personnel, who continued the extrication efforts.

Because the derailed train cars blocked McKnight Road at the grade crossing, three separate staging areas were established. The first, as noted above, was on the unpaved road to the west of the tracks, near the wreckage pileup. About 10:13 p.m., a second fire department field command post was established at the southeast corner of the intersection of McKnight Road and Route 50 at a vacant lumber yard. This was referred to as the "east staging area." A police department field command post was established shortly thereafter at the northeast corner of the same intersection.

About 10:22 p.m., incident command issued a radio request to responding agencies seeking fire suppression foam. Several units responded, but each carried a small number of 5-gallon containers of foam and eductor systems designed to mix the foam with water for application to a fire.

[7] Refers to 5-gallon containers of aqueous film-forming foam or similar foam concentrate.

About 10:24 p.m., the 5-inch hose supply line that was laid along the unpaved road was fully charged and supplying water at the west side of the site. Fire suppression on the burning locomotive recommenced shortly thereafter.

Upon evacuation, displaced passengers and traincrew were taken to one of two triage areas initially established at the scene. Because the temperature that night was estimated to be in the low 20s, however, the incident commander became concerned about the threat of hypothermia, since most of the evacuees lacked warm clothing. A local retail store offered its facility as a temporary shelter, and starting about 10:28 p.m., responders used this facility both as a shelter and as a triage site for several persons who were later found to have sustained injuries.

About 10:30 p.m., incident command requested that a medical trauma team consisting of physicians and medical equipment from local hospitals respond to the scene. About this time, police officers were extricating passengers through the emergency exit windows of an overturned coach car (No. 34089) that lay on the eastern side of the pileup. A Manteno Fire Department pumper truck depleted its water tank by supplying a stream of water to the top of this car in an effort to cool it. About 10:34 p.m., Manteno firefighters made a radio request to incident command that water be applied to the "top of the train" because they were out of water. Incident command, on the western side of the pileup, mistakenly understood the request to originate from personnel inside sleeper car 32035 (the car that was wrapped around the locomotive), and the Bourbonnais Fire Protection District chief responded with a master stream water application[8] onto the west end of that car. Continuing attempts were made to set up a hydrant flow to resupply the Manteno fire trucks on the east side of the scene.

About 10:38 p.m., the Braidwood Fire Department heavy rescue truck arrived at the east side staging area. It was directed to proceed to the west side staging area.

About 10:39 p.m., the trauma team arrived, and they were directed by incident command to the west side staging area.

A responding Braidwood Fire Department officer, who was also the emergency response administrator of a petrochemical operation in Elwood, Illinois, said that shortly after he arrived on scene about 10:40 p.m., he recognized that the fire suppression foam at the scene was almost exhausted. He said he also realized that the fire suppression effort had not been effective in extinguishing the locomotive fire. The fire, as he observed it, was "3-dimensional" and petroleum-based, and it remained entrenched within the upper confines of the locomotive carbody wreckage, which made suppression access particularly difficult. He stated that he believed the strategy being used up to that point was having only limited success, because the fire would be extinguished in one location, only to re-ignite in an adjacent location and flash back to the original location. Further, the fire was directly impinging upon and passing beneath the still-occupied sleeper car 32035.

[8] A *master stream* is an application of a large volume of water (about 350 to 1,000 gallons per minute), typically using a vehicle-mounted "deck gun monitor" nozzle.

From this, the Braidwood officer concluded that the application of a large volume of fire suppression foam might be an effective attack strategy and that, therefore, a heavy foam tanker truck from the nearest available facility should be used. The Braidwood officer discussed with the incident commander the possibility of organizing a mutual aid heavy foam tanker truck response to the scene.

The incident commander concurred with this proposed strategy, and the Braidwood officer immediately placed a cellular telephone call asking that a heavy foam tanker truck and personnel from the Stepan Chemical Company near Joliet, Illinois, be dispatched to the accident site. The officer arranged for a similar request to be made to a Mobil Oil refinery. Both facilities are about 35 miles away from the accident scene, and the officer anticipated that the trucks might require about 45 minutes to arrive.

About 10:44 p.m., a radio transmission went out requesting that the Chicago combined agency response team (CART) immediately respond to the east side of the pileup because, according to the transcript, two people were trapped inside a rail car and fire was impinging. The CART is a tactical rescue squad composed of fire and rescue departments across the suburban Chicago area.

About 10:47 p.m., the Braidwood Fire Department heavy rescue truck arrived at the west side staging area. It was then used as a fire suppression field command post.

About 10:55 p.m., incident command issued a request to all responding agencies for all available water tanker truck support.

About 11:19 p.m., incident command radioed that the main body of the fire on the east side of the scene appeared to have been “knocked down,” which suggested that the fire was somewhat in control, although not extinguished, in that area.

About 11:30 p.m., a heavy foam tanker truck from Stepan Chemical Company arrived and was directed to the west side staging area. About 11:45 p.m., the foam tanker truck reached the west side staging area and set up near the wreckage pileup. The Braidwood Fire Department officer who organized the Stepan response directed that water supply connections be made to one of the pumper trucks stationed at that location and that fire suppression by hand-line commence immediately. Fire suppression water/foam solution was applied to the main body of the fire in the proximity of the locomotive and the sleeper car until the fire was extinguished; the fire was out within a few minutes. Water/foam solution application continued periodically thereafter, because firefighters were concerned that hot metal in the wreckage might re-ignite the fire.

About 12:05 a.m. on March 16, an emergency shelter established at a nearby school building began to receive the uninjured displaced passengers who were transferred from the temporary shelter established earlier at the retail store. This shelter, staffed by the American Red Cross and by the Bourbonnais Police Department, remained open until 2:30 a.m.

Several minor rekindle events occurred in the wreckage at times throughout the night; the fires were quickly extinguished by firefighting crews that remained on the scene. The fire was completely extinguished by dawn on March 16.

About 6:30 a.m. on March 16, a temporary morgue was established at the vacant lumber yard located at the intersection of McKnight Road and Route 50.

About 11:00 p.m. on March 19, the Bourbonnais Fire Protection District incident command post that had opened at the onset of the event was closed.

Injuries

Train 59 carried 207 passengers, 17 on-duty Amtrak crewmembers, and 4 off-duty Amtrak and IC railroad employees. According to hospital records, 121 of these passengers and railroad employees, as a result of this accident, were transported to local hospitals for medical treatment. Thirty-five of the transported patients were examined and released without receiving documented medical treatment. One train crewmember was airlifted from Provena St. Mary's Hospital to the Loyola University Medical Center in Chicago. In addition, the driver of the truck involved in the accident, a responding firefighter, and a responding sheriff's deputy reportedly sustained minor injuries; they were treated and released at a local hospital. Eleven train passengers, all of whom were located in sleeper car 32035, sustained fatal injuries. (See table 1.)

Table 1. Injuries

Type	Amtrak Crewmembers[a]	Amtrak Passengers	Other	Total
Fatal	0	11	0	11
Serious	5	29	0	34
Minor	4	51	0	55
None	12	116	0	128
Total	21	207	0	228

49 CFR 830.2 defines *fatal injury* as "any injury which results in death within 30 days of the accident" and *serious injury* as "an injury which: (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burn affecting more than 5 percent of the body surface."

[a]Included in these totals are two off-duty Amtrak employees and two off-duty IC Railroad employees.

The Safety Board was unable to definitively establish how many individuals were in the sleeping car at the time of the collision, nor could it determine the precise whereabouts of those who were in the car. The degree of injury sustained by the car's occupants ranged from minimal or none, up to fatal. The fatally injured occupants were in the portions of the car at the vertex of the car's bend, where the crush and intrusion were at a maximum. This portion of the car was also later consumed by fire. Rescuers reported that they were unable to immediately extricate some of the individuals they believed to be entrapped within the wreckage; the Kankakee County coroner tentatively attributed injuries of 5 of the 11 fatally injured occupants to the effects of the fire. The coroner was unable to determine whether any of these 5 might have succumbed to their traumatic injuries had they not been exposed to the fire.

The Safety Board disseminated a questionnaire to the accident survivors, but relatively few forms were returned; for this reason, it is not possible to determine which car any individual was occupying at the time of the accident. Five cars on the train were deadheading (not in service). These cars, in addition to the second locomotive and the baggage car, were reportedly unoccupied at the time of the collision.[9] The occupants of the other passenger cars in the consist sustained injury severities ranging from no injury to critical injuries.

Personnel Information

Truckdriver

The accident-involved truckdriver, aged 58, had been driving commercial vehicles since about 1960. He had been traversing this crossing 5 days per week for about 7 years at the time of the accident. The truckdriver had worked for Melco Transfer, Inc., as an owner-operator since 1990.

According to the accident truckdriver's motor vehicle record as certified by the Illinois Secretary of State, the accident driver was cited and had convictions entered for the following speeding violations before the accident:

Date	Reason	State	License cited
February 9, 1992	70/60 mph zone	Illinois	CDL
June 12, 1996	70/60 mph zone	Illinois	CDL
August 20, 1997	70/60 mph zone	Indiana	CDL
June 18, 1998	75/60 mph zone	Indiana	CDL
February 9, 1998	1-10 mph over	Indiana	CDL

[9] Because of the order of the cars in the consist, passengers in car 13, in order to reach the lounge car or the dining car, would have had to pass through two of the deadheading cars.

The accident driver's CDL was suspended for failure to pay the fine associated with the June 18, 1998, speeding citation, but it was reinstated on September 29, 1998. Illinois has a uniform citation form that indicates whether a violator holds a CDL and whether the violator was operating a commercial vehicle. This information is entered in the driver's motor vehicle record. Illinois also enters violation information from other States. Because of this information interchange, the State of Illinois noted that the truckdriver had received three citations within 1 year in Indiana. On this basis, in the fall of 1998, the State of Illinois informed the truckdriver that his CDL would be suspended after 90 days, effective January 25, 1999. When the truckdriver was notified that his CDL was subject to suspension, he enrolled in the National Safety Council's driver improvement program. Following the truckdriver's successful completion of this course in January 1999, the State of Illinois issued the accident driver a probationary license for a period of 60 days beginning on January 25, 1999, and ending on March 25, 1999.[10]

In May 1999, following the accident, the truckdriver's license was again suspended for 60 days, because he was convicted of two serious traffic violations during a 3-year period (two of the four speeding violations). The driver's CDL was reinstated on August 1, 1999. In November 1999, the same truckdriver was cited for a moving violation and received court supervision. He was not convicted, and his license was not suspended.

The citations instigating the initial license suspension were related to speeding, and not to grade crossings. However, in 1999, the U.S. DOT's Federal Highway Administration added a regulation creating a new category of offenses for which a CDL holder may be disqualified from operating a commercial motor vehicle. The rule specifically covers convictions for six types of offenses, including failure to obey traffic control devices at grade crossings. Under the rule, conviction for one of six specific violations at a grade crossing results in an automatic CDL suspension of not less than 60 days. Upon the second conviction within a 3-year period (for a separate incident), the driver must be disqualified for 120 days. Following a third and subsequent violation within a 3-year period, a driver must be disqualified for not less than 1 year. The accident truckdriver was not charged with a grade crossing violation as a result of this accident. Following the accident, however, the Federal Office of Motor Carrier Safety[11] conducted a compliance review of Melco Transfer, Inc., that resulted in fines for both the motor carrier and for the accident truckdriver. The Federal Motor Carrier Safety Administration has elected not to pursue the case further, but instead has turned the case over to the DOT's Office of the Inspector General, who is conducting a criminal investigation into circumstances surrounding this accident. In October 2001, the accident-involved truckdriver was indicted by a Kankakee County grand jury on two counts. One count of the indictment alleges that he falsified his logbook. The second alleges that he violated the hours of service regulations. Both are felony charges.

[10] Under the Motor Carrier Safety Improvement Act of 1999, effective January 23, 2000, States are now prohibited from awarding a probationary license to a CDL holder while he or she has been disqualified from operating a commercial motor vehicle.

[11] On January 1, 2000, the Office of Motor Carrier Safety was redesignated the Federal Motor Carrier Safety Administration.

The truckdriver possessed a valid medical examiner's certificate at the time of the accident. The certificate indicated that the driver was qualified for his duties only when wearing corrective lenses. The driver stated that he wears glasses for reading and while driving, although his driver's license has no vision restrictions. He stated that he wears the glasses when he drives because they are light-sensitive lenses. He was wearing the glasses, which corrected his vision to R=20/20 and L=20/30, at the time of the accident. He reported that his hearing is normal.

The truckdriver characterized himself as a social drinker. He said he had never been treated for alcohol or other substance abuse, and he said he had never used any illicit drugs.

Shortly after the accident, Safety Board investigators compiled the activities of the truckdriver for the 72-hour period before the accident using the truckdriver's statements, his logbook, and materials from the Illinois State Police investigation. A preliminary compilation indicated that the truckdriver had been driving for about 10 hours and had been on duty for another 2 hours in the 24-hour period before the accident. However, during the accident investigation, investigators discovered a fuel receipt that contradicted the driver's account of his whereabouts on the day before the accident. When confronted with the evidence by investigators, the truckdriver submitted a revised statement. Based on the driver's revised statement, the driver's logs, fuel receipts, mileage/speed estimates, and interviews with shippers and receivers involved in the truckdriver's deliveries on the day of the accident, the Safety Board compiled the following list of activities for the truckdriver for the 72-hour period before the accident: (The times listed are approximate.)

Friday, March 12, 1999

8:00 p.m.: Arrived at home near Peotone, Illinois, after loading his truck with steel at Birmingham Steel in Bourbonnais. The driver parked his truck at Melco Transfer, about 2 miles from his home. On his way home, he stopped at a tavern in Manteno, Illinois, where he ate dinner and had several beers.

10:00 p.m.: Went to bed after falling asleep while watching television.

Saturday, March 13, 1999

7:00 a.m.: Awoke, ran errands during the day, and stayed at home. Slept during the night at home.

Sunday, March 14, 1999

7:00 a.m.: Awoke, and stayed at home throughout the day attending to personal matters.

9:30 p.m.: Went to bed.

Monday, March 15, 1999

12:00 a.m.: Awoke and got ready for work.

2:00 a.m.: Arrived at Melco Transfer in Peotone, Illinois, checked truck and departed for Dayton, Ohio.

3:20 a.m.: Stopped in Rensselaer, Indiana, (62 miles, see figure 4) for fuel and a coffee break.

3:45 a.m.: Departed Rensselaer.

7:30 a.m.: Arrived at Dayton, Ohio, (210 miles) where rebar was off-loaded by others. (The driver reported that he rested in the sleeper of his truck while the off-loading was taking place.)

8:45 a.m.: Departed Dayton en route to Canal Winchester, Ohio, to pick up a load of lift-trucks and various accessories.

10:25 a.m.: Arrived in Canal Winchester, (87 miles) where his truck was loaded. (The driver reported that he rested in the sleeper berth during loading, but the shipper indicated that drivers usually participate in the loading of their trucks.)

11:00 a.m.: Departed Canal Winchester en route to Country Supply in Peotone, Illinois.

1:10 p.m.: Stopped in Eaton, Ohio, (112 miles) for food and fuel.

2:30 p.m.: Departed Eaton.

7:00 p.m.: Arrived at Country Supply (251 miles) and assisted with off-loading.

8:00 p.m.: Departed Country Supply and went home, about 2 miles from Country Supply. (The driver stated that he slept at home.)

8:30 p.m.: Departed home en route to Birmingham Steel.

8:45 p.m.: Arrived in Bourbonnais (10 miles). Went off duty for about 45 minutes while his truck was being loaded with rebar.

9:30 p.m.: Secured the cargo on his trailer.

9:45 p.m.: Departed the steel mill, just before the accident.

Train Operator

Title 49 *Code of Federal Regulations* (CFR) 217.11 stipulates that each railroad must periodically test and train its employees on the company's operating rules. Title 49 CFR 240 requires that locomotive engineers be certified every 3 years.

Figure 4. Truckdriver's route on Monday, March 15, 1999

In testimony at the Safety Board's public hearing, the train engineer, aged 52, stated that he had worked as a railroad engineer for almost 25 years before this accident. Records indicate that he was hired by Amtrak on March 18, 1987. According to his testimony, the engineer had operated over the territory in which the accident occurred for 12 years before the accident date, and records showed that his original qualification date over that territory was December 2, 1988. Amtrak terminated the engineer's employment on July 18, 1989, for passing a stop signal. He was reinstated on August 10, 1989. He was again terminated on March 26, 1990, for incurring three rules violations.[12] Amtrak subsequently rehired the engineer on October 1, 1990. Records showed that the engineer was recertified in 1990, 1994, and 1996. His most recent engineer evaluation before the accident occurred on August 1, 1998.

The engineer's most recent medical examination before the accident was on October 13, 1998. His most recent vision and hearing test before the accident took place on September 23, 1996. No restrictions were placed on the engineer relating to his hearing or vision.

The Safety Board was not able to obtain from the train engineer a description of his activities, including a detailed work/rest history for the 72 hours before the accident. The engineer was hospitalized with injuries sustained during the collision and could not recall his activities beyond the fact that he slept much of the day on March 15, 1999, and that he went on duty that evening at 7:15 p.m. He also stated that he had been off duty

[12] The violations involved derailing cars, failure to observe and obey speed limit, and violations of operating rules and instructions.

Saturday and Sunday, March 13 and 14. He was unable to provide specific information about the duration of his sleep periods over those 2 days. He did state that he felt rested when he reported for duty on the evening of the accident. Records indicate that he was in compliance with Federal hours-of-service regulations.

No adverse driver's license information was developed about the engineer during a search of the national driver's register. The engineer said that he was not overtasked/overworked on the evening of and before the accident, nor was he distracted or preoccupied before the accident.

Train Information

Amtrak train 59 consisted of 2 locomotive units, a baggage car, and 13 passenger cars of various types.

The Safety Board examined the derailed locomotives in order to determine the extent to which the locomotive's design provided for the survival of the traincrew members. Both locomotive units were GE model P-40 Genesis locomotives and were operating in the cab-forward position. This model locomotive is equipped with two collision posts immediately behind the front fascia panel. The impact with the truck occurred at the front of the lead locomotive, the only locomotive occupied by traincrew (the lone engineer). The front fascia panel of this locomotive sustained about 12 inches of intrusion. Despite this impact damage, however, the collision posts remained intact. Following the collision, the lead locomotive unit separated from the second, continued along the right-of-way for about 560 feet, and came to rest almost fully on its right side. The baggage car came to rest partially on top of the lead locomotive, crushing the aft end of the locomotive carbody and frame.

Directly behind the two locomotives followed a baggage car, a crew dormitory (transition sleeper) car, and sleeping car 32035. The accident's 11 fatalities were sustained in car 32035. As a result of the derailment and subsequent pileup, the sleeping car came to rest bent and wrapped around the aft end of the second locomotive unit. The carbody, bent an estimated 56 degrees, sustained substantial crush damage and a large breach area where it made contact with the second locomotive. In addition, the aft end of the car experienced a longitudinal twist of about 50 degrees. The left front sidewall was displaced and crushed inward about 6 feet through impact with the forward end of coach 34089, a following car. A length of running rail also longitudinally penetrated the lower level of the carbody, piercing several of the sleeping compartments. In addition to the crush and deformation damage caused by the derailment, a fire, ignited in fuel that spilled from the second locomotive and that migrated underneath the sleeping car, impinged on this car, which then itself ignited. An inspection of the interior of the sleeping car revealed that most of the partitions, fittings, and fixtures in the forward two-thirds of the car were catastrophically crushed and consumed by fire; the material in the aft one-third showed evidence of smoke damage.

The Federal Railroad Administration (FRA) requires locomotives to receive a daily inspection. The locomotives of train 59 received this inspection in Minneapolis/St. Paul at 7:00 a.m. on March 15. The locomotive units, fueled and serviced in Minneapolis, were scheduled to be refueled at Memphis, Tennessee. An initial terminal air brake test and an equipment inspection, as required by 49 CFR 232.12, were performed on train 59 by Amtrak mechanical personnel (carmen, machinists, and electricians) at Chicago Union Station at 6:50 p.m. on March 15. No defects were noted.

While train 59 was operating over IC track, its movements were governed by *Illinois Central Railroad System, Operating Rules—Second Edition*, effective November 1, 1998. The accident occurred on the Chicago District, which was a single main track controlled by a train dispatcher at Homewood, Illinois, according to a traffic control system.[13] The trains were authorized by signal indication through a centralized traffic control (CTC) system, whereby train movements over routes and through blocks is directed by signals controlled from a single point.[14]

Motor Carrier Information

The truckdriver was an owner-operator and owned the accident truck tractor, while Melco owned the trailer. The accident load was being transported under Melco authority. Melco is an authorized for-hire interstate carrier that was established in 1986. At the time of the accident, the carrier operated 41 trucks and owned or leased 55 trailers, primarily hauling steel throughout the Midwest. According to the company, about 95 percent of Melco drivers were owner-operators. Melco vehicles accumulated a total of 2,926,355 miles in the 12 months ending February 28, 1999.

After the accident, on March 17, 1999, the Federal OMC conducted a compliance review of Melco. The five evaluation areas and the final ratings were as follows:

- General (49 CFR Parts 387, 390): Rating—Satisfactory
- Driver Qualification (49 CFR Parts 382, 383, 391): Rating—Satisfactory
- Operational Driving (49 CFR Parts 392, 395): Rating—Unsatisfactory
- Vehicle Maintenance (49 CFR Parts 393, 396): Rating—Conditional
- Accidents (1.367 per million miles): Rating—Satisfactory

[13] According to 49 CFR Part 236, a traffic control system is a block signal system under which train movements are authorized by block signals whose indications supersede the superiority of trains for both opposing and following movements on the same track.

[14] Association of American Railroads. 1991. Recommended definitions for technical terms used in railway signaling. Washington DC.

Title 49 CFR Part 395 requires motor carriers to maintain drivers' log records for a period of 6 months. The OMC compliance review determined that the company had not kept accurate records of duty status[15] for about one-half of the drivers reviewed.[16] As noted above, this category was rated "Unsatisfactory." The OMC review of the carrier's maintenance records revealed that the carrier had failed to maintain records of repairs and maintenance. The OMC noted that the carrier also lacked a means to indicate the nature and due dates of these repairs and maintenance.

Melco Transfer, Inc., was given a "Conditional" rating and fined $4,050 as a result of the review. The driver was also fined $2,000 for falsifying his records of duty status. The OMC conducted a return review in August 1999; this review indicated that Melco had corrected the majority of the violations for which it had been cited. As a result, the motor carrier's rating was upgraded from "Conditional" to "Satisfactory."

Previous OMC reviews of Melco were as follows:

- August 26, 1987, Safety Review: No Rating;
- July 31, 1989, Compliance Review: Rating—Satisfactory;
- August 5, 1995, Compliance Review: Rating—Satisfactory.

On the day of the accident, the truckdriver delivered a load of steel from Birmingham Steel in Bourbonnais, Illinois, to Dayton, Ohio. The driver then transported a "back-haul" of lift trucks from Princeton Products in Canal Winchester, Ohio, to Country Supply in Peotone, Illinois. The driver had begun his third trip of the day, with a load of steel, when the accident occurred.

During the investigation, Melco officials indicated that the company had contracted for the two loads of steel and had assigned those loads to the truckdriver; however, these officials stated that they were unaware of the back-haul load. Further investigation revealed that Country Supply—the recipient of the back-haul of lift trucks—and Melco had a routine business relationship and that Melco owned Country Supply until 1997. The two businesses were located in the same industrial complex. Driver and billing records showed that Melco drivers, including the accident driver, frequently transported loads between Princeton Products and Country Supply, and Country Supply was billed by Melco for transportation services associated with these deliveries. According to the records, these shipments were always arranged by Country Supply. According to Country Supply representatives, the company never received a bill for the back-haul load on the day of the accident.

[15] Title 49 CFR Part 395(e) Failure to complete the record of duty activities of this section or 395.15, failure to preserve a record of such duty activities, or making of false reports in connection with such duty activities shall make the driver and/or the carrier liable to prosecution.

[16] Since no verifiable records were available for checking the accident truckdriver's records of duty status, scale tickets were acquired from Birmingham Steel Corporation near the accident site. About 80 percent of the freight transported by this truckdriver came out of this plant destined for Dayton, Ohio.

Investigators attempted to determine how the companies for whom the truckdriver delivered loads on the day of the accident scheduled their loads for movement. Birmingham Steel indicated that it would not load or off-load trucks between 11 p.m. and 7 a.m., but otherwise the company did not prescribe specific pick-up or deliver schedules. Likewise, neither Country Supply nor Princeton Products, the companies involved in the back-haul load, prescribed specific schedules. A review of Melco records showed that loads involving the carrier were assigned and scheduled in a variety of ways. Melco specifically scheduled some loads, others were generally scheduled (to be accomplished during some time period), and still other loads were assigned to drivers but were self-scheduled by the drivers themselves. Some drivers called in for loads, and others picked up loads on their own and then notified the company. The Safety Board was unable to ascertain who determined the schedule for the back-haul load on the day of the accident.

Truck Information

The accident truck consisted of a truck tractor and semitrailer. The truck tractor was a 1994 Navistar 9400, which is a conventional cab with a sleeper berth. The semitrailer was a 1991 Reitnouer 48-foot aluminum spread-axle flatbed.

The semitrailer was loaded with six bundles of rebar, with each bundle containing 88 bars. The bundles were loaded three-over-three across the center of the bed, with 4 x 4 timbers placed laterally underneath and between the two layers. The 60-foot lengths of rebar extended 5 feet beyond the front and 7 feet beyond the rear of the 48-foot trailer bed. The load was secured with six nylon straps spaced 8 to 10 feet apart. The 46,000 lbs. of rebar, added to the truck semitrailer unit empty weight of 28,880 lbs., brought the gross vehicle weight to 74,880 lbs. The estimated payload weight over the axles of the truck tractor (21,500 lbs.) and the semitrailer (24,500 lbs.) was within the rated capacity of the unit (80,000 lbs.). The overall length of the vehicle, with the load extending over the rear of the semitrailer, was estimated at 77 feet.

Track and Signal Information

Track Information

Two parallel IC tracks, oriented geographically in a northerly to southerly direction, intersected McKnight Road at the grade crossing where the accident occurred. The westernmost track was the main track, and the easternmost track was a passing siding. At the point of collision, the distance between the two tracks, centerline to centerline, was 14 feet. A scheduled total of 4 Amtrak passenger trains, 4 Norfolk Southern Railroad freight trains, and 16 IC freight trains operated over the crossing each day. In addition, a local switch engine makes several moves daily in the vicinity of the crossing.

The IC railroad owned, operated, inspected, and maintained the tracks and track structure. The main track met FRA standards for class 5 track, allowing a maximum operating speed of 79 mph for passenger trains, 70 mph for intermodal[17] trains, and 60 mph for freight trains. The siding track was designated class 2, allowing a maximum operating speed for all trains of 20 mph.

To the north and south of the McKnight Road crossing were additional siding tracks that paralleled the IC tracks on the west side of the main track. To the north of the crossing were two siding tracks owned by Lambert Grain Company. To the south were two tracks owned by Birmingham Steel. The freight cars involved in this accident were standing about 464 feet south of the centerline of McKnight Road on Birmingham No. 1 track, which was the nearest of the two siding tracks to the IC main track.

Train engineers are required to sound the train horn in a standard blast sequence upon the approach to a grade crossing. To notify the engineers when they should begin the horn blast sequence, the railroad installs signs on the railroad wayside, known as whistle posts. In the case of the McKnight Road crossing, for a southbound train movement, the whistle post is located about 4,000 feet north of the crossing and about 1,400 feet north of the St. George Road crossing. The whistle post is described as a multiple crossing whistle post and bears a sign with the letter “W” above the number “3.” The sign instructed the traincrew to sound the train horn for the next three crossing: St. George Road, McKnight Road, and Larry Powers Road.

Signals

Railroad Traffic Control Signals. Train traffic in the accident area was governed by color light signals controlled by electronic coded track circuits. A hot box/dragging equipment detector[18] equipped with an event recording device was located about 5 1/2 miles to the north of the accident crossing. A computer-aided train dispatcher’s log located in Homewood, Illinois, recorded the movement of trains in the accident area.

Grade Crossing Signal System. The McKnight Road crossing was an active grade crossing protected by bells, flashing lights, and gate arms. The crossing predictor (the activation control mechanism for the crossing signal and gate system) was a Safetran Model GCP-3000, which had been installed on January 23, 1992, to replace an older system. The GCP-3000 is a micro-processor controlled system that detects the speed and location of an approaching train and uses time and distance calculations to predict the train’s arrival time at the crossing. The system then activates the crossing signal devices to provide a preset amount of warning time before the arrival of the train at the crossing. The system is designed to provide a relatively constant warning time at the crossing, regardless of the speed of the approaching train.[19]

[17] *Intermodal* trains include flat cars carrying truck trailers or shipping containers and are referred to as trailer-on-flat-car (TOFC)/container-on-flat-car (COFC) trains.

[18] A *hot box detector* determines whether any journal bearings are overheating. A *dragging equipment detector* determines whether any equipment, such as brake rigging or mechanical connections, is dragging or whether any debris that can damage the track connections, ties, or switches has become lodged under the train.

[19] The time-and-distance calculations assume a constant-speed train. If the train should slow or accelerate appreciably after detection by the GCP system, warning time at the crossing would vary slightly.

The number of seconds of warning time provided by the GCP-3000 can be set via a keyboard/display assembly located in the signals bungalow near the crossing. Maximum warning time is a function of the length of the track circuit and the maximum speed of trains using the circuit. In this case, the speed of the train was assumed to be the maximum authorized speed of 79 mph, and the programmed circuit warning time was 30 seconds; this was the setting for the GCP-3000 at the McKnight Road crossing. Because the system requires up to 4 seconds to determine the speed of the train and make its calculation, a 30-second setting will actually activate the warning lights about 26 seconds before the train arrives at the crossing. The McKnight Road signal system event recorder indicated that the system delivered 26 seconds of warning time.

A data recorder module was installed in the GCP-3000 at McKnight Road. Safetran's Data Recorder Module 80015 allows information pertaining to train movement events and system status messages to be stored in memory. The module maintains a date- and time-stamped record of train warning times, speed of the train when prediction occurred, average train speed (speed of train averaged over entire time train is sensed), and island speed (speed of train when entering the crossing). Additionally, any errors normally detected by the GCP, either internally or in the track circuit, are also recorded.

The data recorder module 80015 recorded the information shown in table 2 at the time of the collision.

Table 2. Data recorded at the time of the collision by the crossing signal system data recorder module.

Warning Time	26 seconds
Speed at Train Detection	73 mph
Speed at Crossing	68 mph
Average Speed	71 mph

The module memory can hold data on about 3,000 events; when memory is full, the oldest data is overwritten by the new data.

The signal system was also equipped with a data recorder interface assembly, 80025, which monitors and records changes of the input state on 16 channels external to the GCP-3000. All 16 inputs on the 80025 assembly are electrically isolated from each other allowing direction to vital circuits. Input changes must typically consist of voltage level changes similar to those produced by relay contact closures.

The crossing underwent an annual inspection on February 3, 1999, during which some buried wires were determined to no longer meet requirements. These wires were replaced with other wires that were present in the same bundle of wires. Following the accident, the Safety Board, in cooperation with the IC railroad, tested the wires in place at the time of the accident; the wires were within specifications at the time of testing. The last monthly inspection before the accident was on February 24, 1999. No exceptions were noted.

Roadway and Grade Crossing Information

Roadway. McKnight Road is a two-lane, 22-foot-wide highway running in an east-west direction. Its easterly terminus is at Illinois 50, a four-lane north-south State arterial with a left-turn center median. At one time, McKnight Road continued in a westerly direction. In the 1970s, it was truncated because of construction of the nearby Interstate 57 and now dead ends about 2,000 feet west of the crossing.

Between the western edge of the railroad right-of-way to a point about 800 feet to the west of the crossing, the roadway is owned by the Village of Bourbonnais. Between the eastern edge of the railroad right-of-way and the intersection of McKnight Road and Illinois 50, the Township of Bourbonnais owns the road. The village maintains the entire road by informal agreement with the township. No speed limit is posted on McKnight Road. In Illinois, the speed limit on unposted roads is considered to be 55 mph.

The pavement was last resurfaced in 1992 and was in good condition. The shoulders were unpaved gravel shoulders, with grass embankments and drainage ditches on both sides of the traveled way. The northern ditch extended to the crossing, with the drainage continuing underneath the tracks via a 30-inch-diameter corrugated steel culvert.

Both the eastbound and westbound approaches to the grade crossing are straight, but each meets the tracks at a slightly different angle. The angle of intersection on the east side is about 80 degrees, while on the west side, the angle of intersection is 82 degrees. McKnight Road has a descending 0.75 percent grade from a point 600 feet west of the crossing to a point 200 feet west of the crossing. From this point to the crossing, the grade raises slightly at an average rate of 0.2 percent.

McKnight Road had no street lighting; however, railroad security luminaires at the railroad signal control building in the northwest quadrant of the intersection provided some illumination of the crossing. In addition, lighting from the steel plant parking lot southwest of the crossing provided some illumination of the eastbound highway approach. It also provided some light to the northwest quadrant. Security lighting on two industrial buildings in the northeast quadrant also provided some illumination.

Birmingham Steel was the primary traffic generator on McKnight Road. The facility operated three work shifts that generated about 150 automobile roundtrips (300 one-way trips) per day. Trucks bringing steel scrap into and taking steel products out of the facility generated about 400 to 600 one-way trips per day. Incoming and outgoing trucks were typically loaded to near their maximum load limits.

Traffic Control Devices. The *Manual on Uniform Traffic Control Devices* (MUTCD), published by the Federal Highway Administration and adopted as law by the States, requires special pavement markings in each approach lane of all paved approaches to grade crossings where automated signals are present.[20] The required markings are an

[20] According to the MUTCD, these markings may be omitted at minor crossings or in urban areas if engineering study indicates that other devices installed provide adequate traffic control.

"X," the letters "RR," a no-passing-zone marking, and certain transverse lines. With the exception of no-passing-zone markings, none of these markings were present on the McKnight Road approach to the accident crossing. The no passing zone on the eastbound approach to the tracks extended 315 feet but was in poor condition. According to Village of Bourbonnais officials, the practice of the village was not to stripe roads of this type and function, and the no-passing-zone markings had not been repainted since the village acquired ownership of the road.

The MUTCD also prescribes the use of certain signs on the approaches to and at grade crossings where deployment of such signs is not made impossible by physical conditions. At the McKnight Road crossing, a 36-inch-diameter railroad crossing sign for eastbound traffic was posted 512 feet west of the most westerly rail. An identical sign for westbound traffic was posted 414 feet east of the most easterly rail. Reflectorized crossbucks were mounted on the railroad masts for east- and westbound traffic. The crossing signs and crossbucks were in good condition. According to the MUTCD, an auxiliary sign indicating the number of tracks at a crossing is optional at crossings equipped with automatic gates. Such signs were not present at the accident crossing.

A driver or pedestrian approaching the grade crossing would have been warned of an approaching train by bells, flashing red lights, and crossing gate arms. To the driver involved in this accident, the west gate was on the approach side of the crossing, and the east gate was on the departure side. The crossing gate masts were 12 feet from the nearest rail.

According to the State of Illinois, a motorist must stop at a grade crossing if the crossing is equipped with a "Stop" sign, if a train is approaching and/or gives a warning, if a flagman indicates a stop is required, or if a train-activated warning device is activated. When approaching a crossing equipped with flashing lights, the driver is required to "*always stop* until it is safe to proceed."[21] If the flashing lights are accompanied by an automatic gate arm, then the motorist is required to stop and remain stopped until the gate is raised again.

Following the collision at McKnight Road, the Canadian National/Illinois Central railroad installed video cameras and recording equipment at McKnight Road and several nearby crossings. Several events at these crossings have since been called to the attention of the Safety Board. In one, occurring in August 2000, a truck queued in traffic at St. George Road, the crossing immediately to the north of McKnight Road, stopped on the tracks. While the truck was stopped on the tracks, a train approached, activating the signals; the gate lowered behind the truck cab. The truckdriver succeeded in backing off the tracks but damaged the signal gate. In other instances at McKnight Road, local police received reports that the signal provided inadequate warning time. Review of the video tapes has shown that only one of these reported incidents was truly a delayed activation, which was caused by a broken bond wire in a switch south of the crossing. In the other instances, review of the tapes shows either warning times in excess of the Federally required minimum time, or truckdrivers entering the crossing in violation of the already activated signals.

[21] State of Illinois Secretary of State. 2000. *Illinois Rules of the Road*.

Meteorological Information

The National Weather Service in Chicago, Illinois, reported unrestricted visibility at 10 statute miles and no precipitation at the time of the accident. The temperature was reported to be 33° F. The train engineer and other witnesses indicated that visibility was good, other than the darkness of the night.

Toxicological Information

Truckdriver

Postaccident drug and alcohol testing of the truckdriver was directed by the motor carrier in accordance with Federal requirements. The tests were negative for alcohol, cocaine, marijuana, phencyclidine, amphetamines, and opiates.

At the request of the Safety Board, the Civil Aeromedical Institute (CAMI) Toxicology and Accident Research Laboratory of the Federal Aviation Administration tested the blood and urine specimens submitted by the truckdriver following the accident.

The CAMI tests detected tramadol, a narcotic-like painkiller, both in the urine and at very low levels in the blood. Verapamil, an antihypertensive medication, was detected in the blood and urine, and norverapamil, a metabolite of verapamil, was also detected in the blood and urine. Ephedrine, pseudoephedrine, and phenylpropanolamine, which are primarily used as decongestants but are also found in many nutritional supplements, were detected in the blood and urine, and salicylate (aspirin) was found in the urine and at low levels in the blood. The truckdriver stated that he had taken prescribed medications daily for hypertension and rheumatoid arthritis for a period of 6 years before the accident. He said he also used a painkiller as needed for a pulled leg muscle.

Amtrak Crew

Federal regulations do not require postaccident toxicological testing[22] of train crewmembers involved in highway/rail grade crossing accidents; thus, the crewmembers of train 59 were not tested. The engineer stated that he had not used alcohol or drugs, including over-the-counter and prescription medication, before the accident.

Postaccident Inspection

Site Inspection

Postaccident inspection of the crossing on March 16 revealed a black tire mark about 18 feet long on the rails and on the crossing timbers between the rails of the siding

[22] Title 49 CFR 219.201(b).

track. (See figure 5.) One end of the tire mark began just west of the west rail north of the centerline of the roadway. It ran over the west rail and continued diagonally between the rails to the edge of the crossing timbers near the east rail and ended on the east rail, about 4 feet from the edge of the timbers.

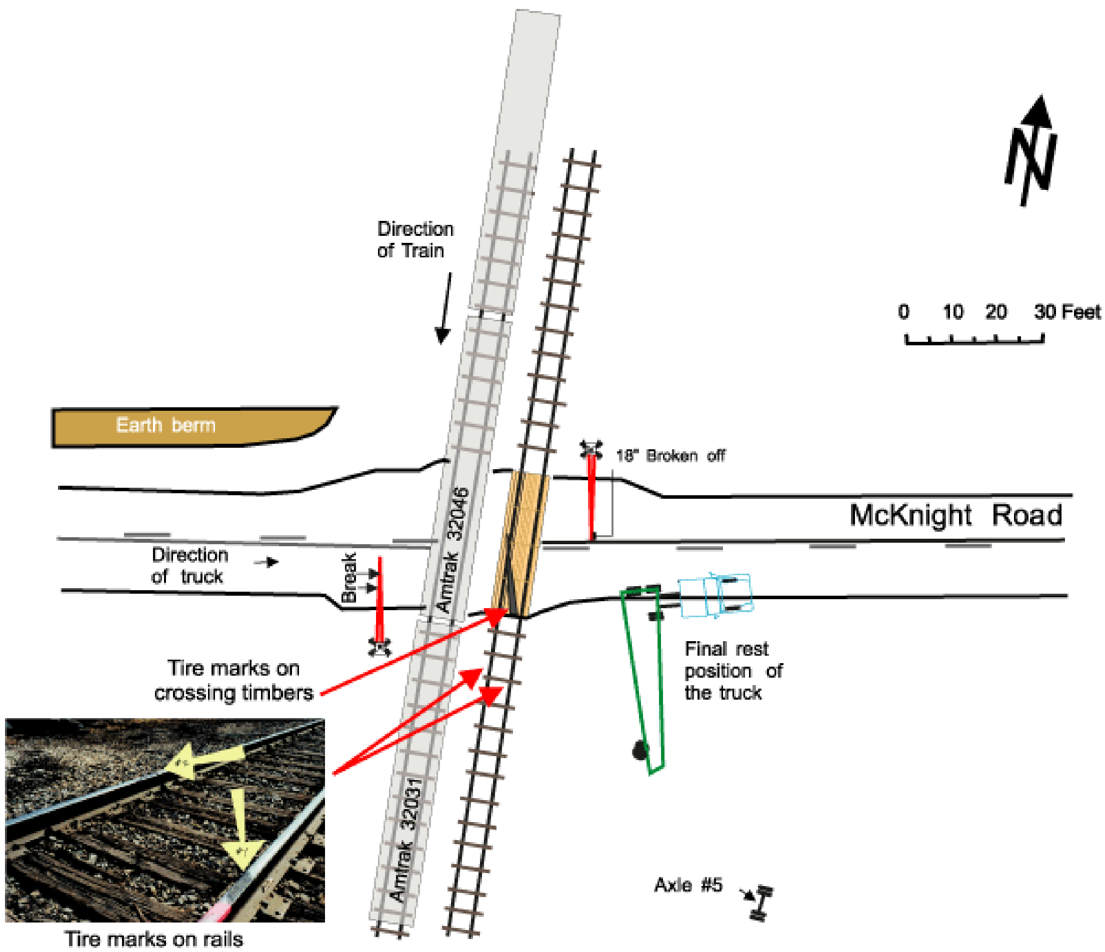


Figure 5. McKnight Road grade crossing showing damage features and tire marks.

Two additional tire marks were found on the passing siding track rails south of the crossing timbers. The first of these was found on the west rail about 12 feet from the timbers. The second mark was found on the east rail about 18 feet from the timbers.

The northerly end of the black tire mark on the timbers of the easterly track indicates the position of the tires when the truck was hit by the train. The only tires showing sideways sliding were those on the left side of the fourth axle. It was therefore concluded that the marks were made from the left tires of the fourth axle. A 10-foot measurement (distance between the fourth and fifth axles) indicated that the fifth axle had to be at the center of the southbound tracks at impact. This was confirmed by noting the damage to the left outside wheel of the fifth axle, which was consistent with the geometry of the locomotive's front coupler. (See figure 6.)

Figure 6. Left-side fifth axle of semitrailer at point of impact.

The tire marks on the rails indicate the path of the rear of the trailer on its way to its point of final rest. The accident reconstruction study (discussed later in this report) used these marks and the tire mark noted above, among with other inputs, to determine the placement and speed of the truck at the time of collision, and its path to its point of final rest.

Examination of Gate Arm Mechanism Components

The base of the west crossing gate signal mast was cracked. This was the gate that was on the approach side of the crossing from the perspective of the accident truckdriver. The front edge of a flange on the case metal base and a section of the base itself bore a series of indentations. Witness marks on the concrete under the base of the crossing signal mast indicated that the cast-metal gate mast base had been moved about 1 inch to the west and south of its original position. (See figure 7).

Figure 7. Cracked cast metal base of the west-side crossing gate.

An area of missing paint, where the outer coat was removed while the base or primer coat was left, was found on the west face of the gate at the tip. The gate counterweight, three of the four large signal lights, and the bell had broken off the signal mast. In addition, the gate arm was fractured but not broken off; the mountings for the three lights on the gate arm were broken; and the tip light and base light remained hanging from the gate arm. (See figure 8.) Safety Board investigators were unable to locate the lens for the gate arm center light. The east crossing gate was broken off, in an inward and downward direction, at a point 19 inches from the tip.

As a part of the accident scene cleanup, the IC replaced the damaged west gate arm mechanism. The gate mechanism was discarded and remained in outside storage in Gilman, Illinois, until September 15, 1999, when the Safety Board asked that it be sent to Washington, D.C., for testing. The Safety Board received the mechanism on October 5, 1999. Details of the initial testing and examination of the gate arm mechanism are discussed in further detail in the “Tests and Research” section of this report.

Figure 8. West (approach) crossing gate.

Sight Distance

Sight distance, in this instance, refers to the distances along the highway and along the railroad tracks needed by a motorist to detect the presence of a train in time to stop and avoid a collision. According to the American Association of State Highway and Transportation Officials (AASHTO), which establishes guidelines for the geometric design of roadways, a grade crossing should be designed so that an approaching motorist is able to perceive the train, react to its presence, and stop the highway vehicle before reaching the crossing.

Once the necessary distance is determined, a “quadrant sight distance,” or “sight triangle,” can be established. Two sides of this quadrant sight distance, or sight triangle, are formed by imaginary lines drawn from the highway vehicle to the crossing and from the crossing to the train. The third side is formed by a line drawn from the train back to the highway vehicle. The interior of this quadrant or triangle should remain clear of any visual obstructions.

For a vehicle stopped at the crossing, the driver must be able to see the train far enough along the tracks to have time to accelerate the vehicle and clear the crossing before the train’s arrival. The quadrant sight distance needed varies according to the speed and stopping distances of the train and the highway vehicle. It is also affected by the angle at which the highway intersects the tracks and the slope of the roadway. Train-activated crossing traffic control devices, such as those at the McKnight Road crossing, are often used where permanent visual obstructions exist within the sight distance triangle.

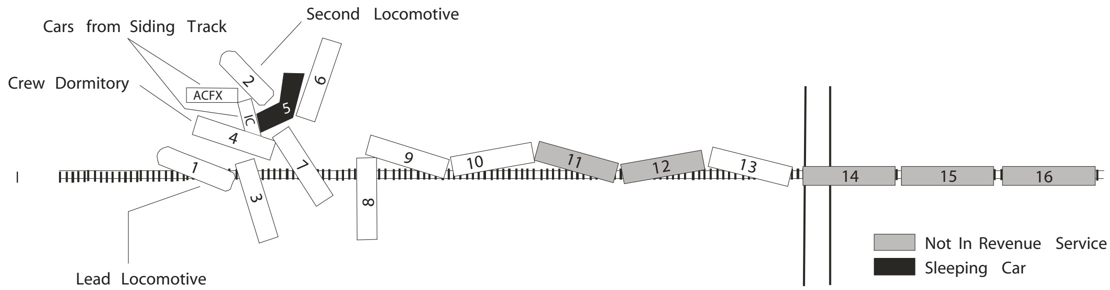
At the McKnight Road crossing, investigators noted several sight obstructions within the sight distance triangle. The sight line across the northwest quadrant, where an eastbound motorist would look for a southbound train, was limited in part by a high berm running along the north side of the highway. From the end of the berm to the tracks, a building and trees limited visibility. At the time of the accident, about 20 freight cars were standing on the Lambert Grain Company side track closest to the main track. The freight car closest to McKnight Road was 376.5 feet north of the centerline of the grade crossing. An approaching southbound train could not be seen until it had cleared this point.

In an ideally designed crossing, the approaching motorist will have adequate quadrant sight distance, allowing a clear view of approaching trains. Of equal importance, however, is the sight distance available for the motorist to see the upcoming crossing, sometimes known as the approach sight distance. Approach sight distance is the distance measured along the highway between the motor vehicle and the crossing, and it must be long enough to enable an approaching motorist to see the crossing (or its warning devices), react to its presence, and stop the highway vehicle safely before reaching the crossing. Where highway conditions such as curves in the roadway or intruding vegetation limit the approach sight distance, additonal measures, such as additional traffic control devices or brush trimming, may be considered.

The Safety Board examined the crossing area to determine whether an eastbound motorist had adequate approach sight distance for the grade crossing on McKnight Road. According to formulae provided by AASHTO, a vehicle traveling about 30 mph along the highway would require about 207 feet to stop safely before encroaching on the crossing. Using an exemplar vehicle, the Safety Board determined the point along McKnight Road at which a truckdriver might first be able to see the crossing or its signals. As mentioned above, the roadway approach was straight. The flashing light signals were visible to the truck occupants at the point where the truck turned onto McKnight Road, a distance of about 650 feet.

Wreckage

Train. The impact caused both locomotives and 11 of the 14 cars in the consist to derail. The lead locomotive came to rest at a point about 560 feet south of the grade crossing. Adjacent to this was the second locomotive, the baggage car, a transition sleeper car, a sleeping car #32035, diner car #38020, and coach car #34089, which came to rest on its side, all of which were involved in a general pileup of wreckage. (See figure 9.) The remaining cars in the consist either derailed and remained upright or did not derail at all. None was involved in the general pileup of wreckage. These cars did not display any evidence of serious carbody breach, and damage was mostly limited to the carbody end-structures.



Position in Consist	Equip. Description	Amtrak No.
1	locomotive	807
2	locomotive*	829
3	bagage car*	1166
4	transition sleeper	39004
5	sleeping car	32035
6	dining car	38020
7	coach	34089
8	coach	31034
9	coach	31540
10	lounge car	33009
11	coach*	35001
12	coach*	31016
13	sleeping car	32031
14	sleeping car*	32046
15	dining car*	38032
16	sleeping car*	32058

*Car unoccupied at the time of the accident

Figure 9. Wreckage diagram (not to scale). Car numbers reflect position in consist.

When the Amtrak train derailed, it struck 2 of 10 freight cars that were on an adjacent siding west of the main track. The northernmost freight car, which was apparently the first to be struck, was a gondola loaded with bars of steel. This car, struck by Amtrak's second locomotive, was crushed, spilling its contents. The second car struck was a covered hopper car containing about 185,000 pounds of dust that was generated by the steel plant's electrical arc furnace and that was considered a hazardous waste. Both cars showed evidence of cargo loss. The remaining freight cars on the siding apparently separated from the first two and were propelled southward on the siding, coming to rest about 1,300 feet from their original location.

Truck. The train struck the left side of the semitrailer at the last (No. 5) axle, which separated from the trailer and came to rest about 80 feet south and 60 feet east of the point of impact. The truck semitrailer combination came to rest in the eastbound lane of McKnight Road with the front of the tractor about 35 feet from the east crossing gate. The tractor's left wheels came to rest just on the edge of the pavement. The trailer remained attached to the tractor, but rotated about 100 degrees counterclockwise around the fifth wheel coupling. (Refer to figure 5.)

Safety Board investigators examined the truck tractor and found no indication of surface abrasion or impact. No marks of any kind were observed on the tractor except for an indentation on the outer edge of the driver's side view mirror; the source for this indentation is unknown.

The bed of the semitrailer, beginning at the fifth wheel coupling and continuing to a point just forward of axle No. 4, was intact but had a clockwise longitudinal spiral twist. The section of the bed rearward of axle No. 4 was dislodged and scattered along the railroad bed for about 100 feet; an exception to this was the left frame rail, which was bent 90 degrees to the left and twisted clockwise about 90 degrees. The semitrailer's load of rebar was scattered along the rail bed for several hundred feet, and many of the bars were bent.

The left wheel rim and drum assembly of the semitrailer's No. 5 axle had heavy impact damage that matched the Amtrak locomotive's coupler in size and conformation. The hub was destroyed, and the brake shoes and air chamber were dislodged. This was the only wheel assembly on the semitrailer that showed evidence of impact damage. The left side dual tires on axle No. 4 showed surface abrasions in one section of the tread area, with striations perpendicular to the tread.

Tests and Research

Tractor and Semitrailer

The mechanical subsystems on the semitrailer could not be tested. The individual components were tested or examined, however, to determine their condition and to determine compliance with the applicable Federal regulations. No discrepancies in the brake system, the suspension system, or the tires were noted. The truck tractor did not receive any collision damage, and postaccident inspection and testing revealed no discrepancies with the steering, suspension, chassis, powertrain, drivetrain, tires, or brake systems on the tractor.

Train Air Brakes

The Safety Board tested the train's air brakes and reviewed equipment maintenance records for the 60 days before the accident. A successful application and release of the train brakes was made with the following cars, 35140, 33009, 35001, 31016, 32031, 32046, 38032, and 32058. Car 31034 was present but required additional work and so was not tested at the time. After repairs were made to car 31034, it was successfully air-brake tested and moved with the rest of the cars. These cars were later joined by car 39004, and the brake system was successfully tested for movement. No defects were found that would have indicated that the equipment was impaired at the time of collision.

Grade Crossing Warning System

Beginning with their arrival at the accident scene, and at intervals during the following 2 years, Safety Board investigators conducted numerous tests and inspections on the grade crossing signaling system. Results of the testing of relays, lamp and gate control devices, cables, and the signal system event recorder indicated that all components were operating within manufacturers' specifications.

After the accident, the damaged crossing gate arms were replaced with fiberglass gates. The damaged gate mechanism on the west gate was also replaced. The accident crossing was placed back in service at 9:00 p.m. on March 17, 1999. Safety Board investigators observed the crossing and noted the warning times provided as several trains traversed the crossing. The warning times ranged from 30 to 39 seconds. These warning times were longer than those for which the system was programmed because track repairs caused the railroads to issue slow orders, reducing the authorized train speed near the crossing.

On March 19, 1999, Safety Board investigators conducted tests on both the west and the east crossing gates to measure the warning times provided by the grade crossing signal system. Investigators measured the elapsed time from initial signal light activation to the beginning of the descent of the gates, elapsed time from the beginning of the descent of the gates until the gates were fully horizontal, and the length of time the gates were down (fully horizontal) before the train arrived at the crossing. The time the gates remained horizontal before the arrival of a train was estimated by assuming that the system would provide 25 seconds as a nominal warning time.

For each gate, an average of 4 to 5 seconds elapsed from the time the signal lights were initially activated until the gates began to drop. Another 8 or 9 seconds elapsed before the gates were fully horizontal. The gates were down between 11 and 12 seconds before the train's arrival. Again, the time until a train's arrival was estimated using 25 seconds as a nominal warning time. FRA rules require that crossing gates be in the horizontal position at least 5 seconds before the arrival of the train at the crossing.

Also on March 19, 1999, the Illinois State Police accident reconstruction team conducted tests on the west crossing gate. In those tests, the average elapsed time between the activation of the lights and the initial descent of the gate was also between 4 and 5 seconds. The team recorded an average elapsed time of between 6 and 7 seconds from the time the gate began to descend until it was fully horizontal.[23]

Using wooden replacement gate arms, Safety Board investigators, in conjunction with the Illinois State Police, conducted tests to determine the extent of damage the gates might sustain by being lowered onto a standing load of rebar. The accident truck tractor,

[23] The police reconstruction team used a standard slightly different from that of the Safety Board team when it measured the time required for the gate to reach the fully horizontal position. While both groups measured from the same starting point (initiation of descent), the police team measured the time to the moment the gate reached the horizontal position, whereas Safety Board investigators waited until the gate had completed a small "bounce" when it reached horizontal.

with a semitrailer and cargo similar to those involved in the accident, was positioned so that a lowered gate arm rested on the rebar about 7 feet from the aft end of the rebar bundles. Investigators noted and photographed several marks made on the underside of the gate arm where it struck the rebar, and Illinois State Police took custody of the wooden gate arm. No similar marks were found on the gate arm that was in service at the time of the accident.

On April 15, 1999, Safetran, the manufacturer of the GCP-3000, field tested the predictor system under Safety Board observation. On May 21, 1999, the manufacturer, in the presence of a Safety Board investigator, factory tested the GCP-3000. All testing was performed in accordance with Safetran bench and pre-shipping test procedures for a newly manufactured product. The measured values for the accident-involved GCP-3000 system and modules were within the manufacturer's specifications.

On March 19, 1999, investigators conducted tests to determine whether a similar truck could maneuver around lowered gates at the McKnight Road crossing. The driver provided by the State Police was able to drive the truck-tractor semitrailer around the lowered gates at a low speed. Several timing tests conducted at this time showed that, on average, the exemplar vehicle required about 34.6 seconds to drive from the steel plant parking lot to the approximate point of impact; the vehicle averaged 23 mph on these tests. Also on this date, investigators conducted tests to determine how much time was required by the nearby crane operator to perform his task, in order to develop an estimate of the time elapsed between his first noticing the flashing lights and his witnessing the collision. The average time he required to perform his task was from 24 to 26 seconds.

Grade Crossing Signal Malfunction History

Safety Board investigators examined incident reports filed in 1998 and 1999 for the warning signal system installed at McKnight Road. These reports documented incidents involving both false activation and activation failure. A false activation occurs when the system indicates to a motorist that it is not safe to cross the railroad tracks when, in fact, it is safe to do so. Based on a review of the records, the Safety Board identified reports of four false activations, all of which occurred before March 15, 1999.

An activation failure occurs when the signal system fails to warn of the approach of a train at least 20 seconds before the train arrives at the crossing, or when it fails to indicate the presence of a train occupying the crossing. According to FRA records, a total of 596 activation failures were recorded nationwide during 2000. For each of these activation failures, a cause was discovered. According to the FRA's Grade Crossing Inventory System database, there are 63,243 grade crossings equipped with train-activated warning devices; an average of 15.06 trains use these crossings each day.

Two activation failures at the McKnight Road crossing have been reported since the March 15, 1999, collision. On March 29, 1999, about 12:32 a.m., the signal system provided only 6 seconds of warning time before the arrival at the crossing of a northbound IC freight train. Investigation revealed a broken bond wire in a switch south of the crossing that temporarily shortened the length of the approach circuit and delayed detection of the train by the signal warning system. About 11:29 p.m. on April 9, 1999, the gates began to cycle up and down while a southbound IC freight train occupied the crossing. In this instance, soybean meal had leaked from a car in the train and had built up between the train wheels and the rail. The material effectively acted as an intermittent insulator that prevented the signal circuit from detecting the presence of the train. In both instances, the event recorders indicated that the signal system failed to provide the intended warning time.

Laboratory Examination

The west crossing gate [24] arm mechanism, the gate's counterweight, the gate mast base, and the light bulbs from the gate arm were all examined or tested, or both, by the Safety Board's Materials Laboratory. The wooden crossing gate arm was examined by the Materials Laboratory, and by the U.S. Department of Agriculture Forest Products Laboratory.

Crossing Gate Mechanism. The crossing gate mechanism is that part of the crossing signal system that contains the motor controlling the motion of the gate arm. Normally, the gate is held in the "up" (hold clear) position by an energized relay. When the train enters the signal circuit, the GCP-3000 determines the appropriate train location to activate the lights and gates to provide the warning time. When the train reaches the calculated distance from the crossing, the GCP-3000 de-energizes the crossing control relay inside the signal bungalow, which in turn de-energizes the relay inside the gate mechanism, and a motor begins to drive the gate down.[25] When the gate reaches about 50 degrees from the horizontal, the motor shuts off, and the gate continues to fall by gravity alone. As the gate nears the horizontal, the motor acts as a generator, and slows the gate's descent. The motor again disengages when the gate reaches fully horizontal.

The gate operating mechanism consists of the motor itself, two intermediate gear and pinion sets, and associated roller bearings and pins. The Safety Board's Materials Laboratory marked, removed, cleaned, and examined the gears, roller bearings, and pins of the west gate assembly. All the gear and pinion teeth showed varying degrees of wear but were intact.

Examination of the motor revealed that all the wires were firmly attached, and the commutators and brushes were in good condition. Manual operation of the hold-clear mechanism confirmed that when the gate was in the up position, the motor shaft was locked, as designed.

The Safety Board then reassembled the intermediate gear assemblies using the marks that had been made to ensure that the gears engaged exactly as they had before

[24] From the perspective of the accident truckdriver, the west gate was on the approach side of the McKnight Road grade crossing. This is the gate mechanism that was damaged by the collision and replaced immediately after the accident.

[25] The gate and counterweight assembly are balanced so that the gate will fall by gravity alone; however, a motor is used in case additional force is needed to counteract the effects of strong winds or to overcome other resistance.

disassembly. After assembly, and with the gate in the “down” position, power was supplied to the motor, and the gate mechanism was operated. Safety Board, FRA, and Canadian National/Illinois Central Railroad (CNIC) representatives present at the disassembly and testing demonstration agreed that the gate mechanism operated as designed.

The Safety Board conducted several additional examinations of the electromechanical components of the gate mechanism. On March 29, 2000, investigators reexamined the gate arm mechanism. On May 30, 2000, Safety Board representatives participated in tests of the gate mechanism motor control relay performed at the laboratory of the mechanism’s manufacturer. On July 13, 2000, the Safety Board conducted a teardown of this same relay in its laboratory.

March 29, 2000, Examination. Examinations of the mechanism and its circuits were conducted by Safety Board Railroad Division staff to identify the failure modes that might be expected to affect either the gate mechanism or the overall grade crossing signal system. Specifically, investigators attempted to determine what conditions might cause one or both of the gates to fail to lower, or that might cause a delay in the lowering of one or both gates. Representatives of the CNIC and Alstom Signaling, Inc., (Alstom) participated.

The internal works of the gate mechanism were determined to have been assembled by General Railway Signals Company (GRS), now Alstom. According to records maintained by the CNIC, this particular mechanism was manufactured in 1968. A review of records dating back to 1993, the earliest date for which such records are kept by the manufacturer, found no failures of GRS gate mechanisms, and no safety notices or safety reminders relating to gate mechanisms manufactured in 1968 had been issued by the manufacturer.

The hold-clear mechanism showed no evidence of contamination or material transfer that could have served to physically hold the gate in place after the activation relay was de-energized. After an examination of both the gate mechanism and the circuit diagrams for the mechanism, the examination participants could identify no failure mode within the mechanism that would cause the simultaneous delayed lowering of both gates at a crossing. Participants determined that the most likely cause of a failure of a single gate to lower would be a failure of the motor control relay to open when de-energized. Were this to happen, the hold-clear mechanism would remain energized, and the gate would not be released.

The motor control relay was removed from the gate mechanism case at this time. Simple testing in the laboratory established that the relay still functioned. Participants decided to conduct more rigorous testing of the relay at the manufacturer’s laboratory. This testing was conducted on May 30, 2000.

May 30, 2000, Testing. Safety Board Railroad Division representatives conducted tests at Alstom’s laboratory in Rochester, New York, to determine the exact current levels required for the accident gate mechanism’s motor control relay to function. Present were representatives of Alstom and the CNIC. The measured current levels met manufacturer's specifications.

July 13, 2000, Teardown. The Safety Board disassembled the gate mechanism's motor control relay and examined the relay's contact surfaces to determine whether either foreign material or a transfer of matter from one surface to another could have caused the relay to stick in the closed (energized) position. The contact surfaces did not show evidence of any transferred or foreign material.

Counterweight Assembly and Gate Mast Base. The gate arm's counterweight was broken off during the collision. The Safety Board examined the fracture face, which revealed features consistent with an overstress separation propagating from the inside of the arm (the side closest to the mast) toward the outside.

The base of the crossing gate mast consisted of two castings fastened together around the mast. Four fasteners screwed the two base castings onto anchor bolts embedded in a concrete foundation.

A series of indentations was noted on the front edge (facing the roadway) of a flange on the side of the base. The indentations were spaced about 3/4 inch apart. A second series of larger indentations, spaced about 1 inch apart, were found on the front edge of the inner half of the base. A portion of the front edge of the inner half of the base was cracked and was moved outward to close the gap between the two halves.

Gate Arm Shaft Bearings. The wooden gate arms attach to the gate arm mechanism by way of a metal shaft, the rotation of which causes the gate to lower and raise. The shaft enters the gate arm mechanism and attaches to it with press-fit ball bearings. The inner bearing race rotates with the shaft, while the outer bearing race remains stationary in relation to the mechanism case. The bearing race locations, relative to the gate up and gate down positions, were vibro-peened on the outer edges of the races, and the bearings were removed from the mechanism case for examination.

The bearings were found to have numerous indentations, described as Brinell marks or brinelling,[26] on the active bearing surfaces. (See figure 10.) The presence of brinelling suggests that, at some time, the bearing received a severe blow, causing the bearing surfaces to impact one another. According to bearing manufacturers, typical examples of causes of brinelling include "using a hammer to install a bearing, dropping a bearing, or pressing a bearing onto a shaft by applying force to the non-rotating ring."[27] Other marks were observed and noted, but they did not show the indentations typical of Brinell marks.

[26] *Brinell marks* are indentations at ball/roller frequency caused by any static overload or severe impact.

[27] <http://www.emersonbearing.com/failures/true.html> as of 10/15/2001.

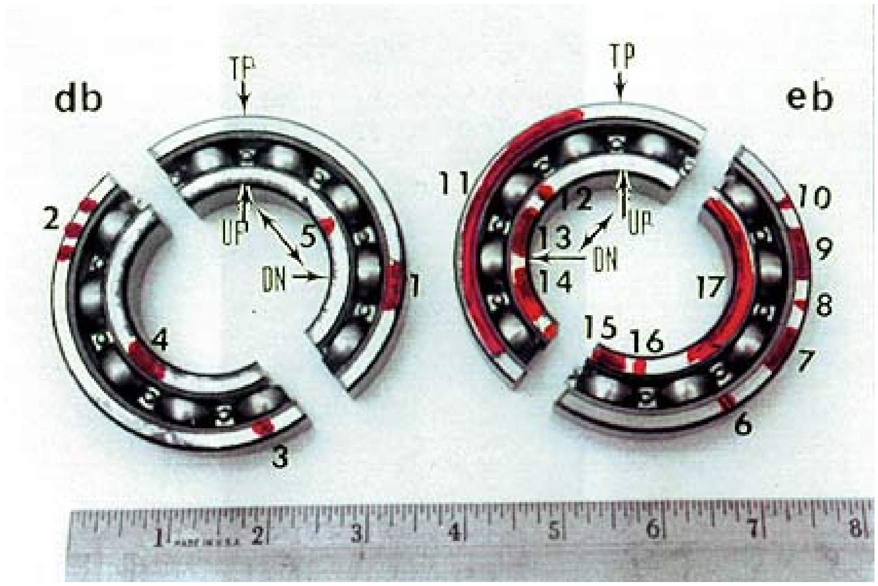


Figure 10. West crossing gate arm mechanism main shaft bearings. Numbered markings on inner and outer races indicate location of Brinell marks.

To determine whether the Brinell marks on the bearing surfaces might have resulted from normal operations, investigators examined a set of bearings from another, similar gate arm mechanism. The ball grooves of the inner and outer races of the comparison bearings bore signs of the balls' rotation in the grooves and of minor surface corrosion. The comparison bearings did not show evidence of Brinell marks on any surface. The rotational signs in the grooves of the inner and outer race aligned to indicate the range of the gate's movement; these were more prominent on the bearing that supported the counterweight arm.

Gate Arm Light Bulb Filaments. The Safety Board also examined the light bulbs from the signal gate arm. If the filaments inside incandescent light bulbs are hot when they receive a blow, instead of breaking, they may simply deform; this was in fact what happened with the two light bulbs the Safety Board was able to recover from the accident gate arm. Because of the way the light bulbs were set in their sockets on the gate arm, the deformation is principally in the direction parallel to the road.

It was hoped that the shape and direction of the filament deformation might provide evidence indicating the orientation of the light bulb when it was struck. To test this hypothesis, the Safety Board tested numerous similar light bulbs at the CNIC signal shop in Homewood, Illinois. Light bulbs were inserted in a block attached to a wooden gate arm. Each light bulb was inserted with the filament oriented in a different direction, and power was supplied to make the light bulbs flash for about 30 seconds before force was applied to the free end of the gate arm. The light bulbs were then removed, labeled, and replaced with fresh bulbs to repeat the experiment. The bulb filaments were examined at the Safety Board's Materials Laboratory under an optical microscope, and the deformations were noted. The examination showed that filament deformations in a specific direction could result from motion in various directions.

Fire Investigation

Following the accident, sleeper car No. 32035 was removed from the accident site and taken to the Amtrak facility in Beech Grove, Indiana. On April 27, 1999, investigators reexamined the car at this facility.

During the course of the derailment, the sleeper car's midsection struck and bent around the end of the train's second locomotive. Spilled fuel from the locomotive's breached fuel tank ignited, resulting in a large fuel-fed pool fire that severely damaged the middle one-third of the sleeper car.

Because of the fire and victim recovery efforts, Safety Board investigators could conduct only a preliminary examination of the sleeper car before Amtrak removed it from the accident scene. To prepare the car for shipment, workers cut it in half, and the forward half of the car was compressed to permit it to fit into a railcar. The remaining sleeper car half was placed on another railcar. Where the car was still accessible to investigators, (on the top deck, room Nos. 5-10), little fire damage was noted, though some discoloration of the interior windows and slight sooting of interior materials was evident. Areas closer to the point of impact showed evidence of burned interior materials.

In 1984, the FRA published guidelines recommending test methods and performance criteria for the flammability, smoke generation, and fire endurance characteristics of the interior materials used in the construction of new or rebuilt rail passenger equipment. The guidelines were originally developed by the Volpe Transportation Research (Volpe) Center in the late 1970s and were intended for application to rail transit vehicles. The intent of these guidelines was to prevent fire ignition and to maximize time available for the evacuation of passengers. The test methods cited in the guidelines include recommended test methods from the American Society for Testing and Materials and the Federal Aviation Administration. These guidelines were codified into full regulations in May 1999.

The flammability of the interior materials (floor and wall covering, seat upholstery, and cushioning) in sleeper car No. 32035 was reviewed. According to testing records provided by Amtrak, the materials met the standards. Testing of materials directed by the Volpe Center produced similar findings.[28]

Two materials, both samples of foam found in the headrests on the sleeper car, were not among the materials tested before the accident. These materials were tested, however, as part of the Safety Board's investigation. The blue headrest foam is a

[28] The National Institute of Standards and Technology (NIST), under the direction of the FRA and the Volpe Center, is currently conducting research involving the fire safety of rail passenger vehicles. The NIST project is investigating the use of alternative fire testing methods and computer hazard analysis models to identify and evaluate approaches to passenger train fire safety. Amtrak provided the materials used in this testing.

polyurethane foam manufactured by Chestnut Ridge. Kevlar cloth is bonded to the foam before installation in order to make it fire retardant. The blue foam, with the bonded Kevlar cloth, was tested by Amtrak. The white headrest foam, tested by the Safety Board, is known as IMPAK SR-10 LS. It is a rebonded foam that is manufactured by STX, Inc. The foam is bonded with fire-retardant cotton muslin to protect it from wear and dust. The white headrest foam used in the testing came from the accident car.

The FRA requires that the flame spread index, which is the measure of surface flammability, fall below 25. The index was 162.6 for the white headrest foam, which is not in widespread use and is being phased out. Since the accident, Amtrak has provided test records indicating that the flame spread index for the blue foam (with cover) was 21.86.

To meet FRA standards for smoke generation, the smoke generation rating must fall below 100 after 1.5 minutes of exposure to a heat source, and below 175 after 4 minutes of exposure. After 1.5 minutes of exposure to a flame source, both types of foam fell within the standard of 100. At 4 minutes of exposure to a flame, the measure rose to 249.5 for the white headrest foam.

Smoke generation tests were also conducted using exposure to a nonflame heat source. During these tests, after 1.5 minutes exposure, the white headrest foam measured slightly over the limit at 105.9, while the blue foam sample measured below the limit. After 4 minutes, the white headrest foam was again above the limit at 292.2, while the blue foam sample measured below the required limit.

Locomotive Event Recorders

The recorders installed in both locomotives involved in the accident were Pulse Electronics solid-state permanent core memory (PCM) modules. The locomotive manufacturer integrates the PCM module into a locomotive data bus that provides data to the recorder system. The PCM records data onto non-volatile solid-state memory. Each parameter is recorded at a rate of 1 Hz (once per second), with the exception of the horn parameter, which is recorded at a rate of 10 Hz (10 times per second).

A PCM module was removed from the lead locomotive, Amtrak unit 807, on March 16, 1999. Damage sustained by the locomotive prevented power from being applied to the PCM system within the locomotive, which made it impossible to extract data from the module while still in place. The module was removed and placed in another Amtrak P-40 locomotive for readout. A representative of Amtrak used locomotive power, recorder manufacturer’s software, and a laptop computer to download the recorded information onto a computer diskette.

Software developed by Pulse Electronics was used to transcribe the data and to produce tabular data and data plots. Approximately 27 hours of locomotive data were present on the recording, and the accident sequence was recorded without any data loss.

The tabular data indicate that the train was traveling about 79 miles per hour as it approached the accident crossing and that the train horn was sounded when the train was more than 3,000 feet from the accident crossing and again when it had approached to within about 1,600 feet of the crossing. The timing of these horn soundings is in accordance with the placement of the 3-crossing whistle post located north of the St. George Road crossing.

A Pulse Electronics PCM module was also removed from the second locomotive, Amtrak unit 829. Unit 829 was exposed to post-impact fire for just over 90 minutes, and the group determined, after observation of the PCM, that readout of the unit was not possible at the scene. Amtrak shipped the unit to the Safety Board's laboratory in Washington, D.C., for further examination and possible readout. Further examination, however, determined that the fire had destroyed the solid-state memory, and that extraction of the data was not possible.

Accelerometers are not fitted on locomotives, and accelerations are not recorded on locomotive event recorders. Without the benefit of acceleration data, all event recorder data were examined to estimate a time of impact. At 9:47:12 p.m., the locomotive current dropped from 368 amps to zero, and, at 9:47:13 p.m., the recorded throttle position changed from 8 to idle. Train speed decreased 79 mph to 78 mph during this time. In addition, the locomotive engineer testified that upon seeing the tractor-trailer on the track and determining that impact was imminent, he reduced the throttle to idle and braced himself for the collision. Based on these data, the earliest the collision could have occurred was 9:47:12 p.m. Between 9:47:13 and 9:47:14 p.m., train speed decreased from 80 mph to 69 mph. Such a deceleration cannot be accomplished with typical locomotive performance and likely occurred when the train struck the tractor-semitrailer. Thus, based on all available information, the time of impact was most likely between 9:47:12 and 9:47:14 p.m.

Accident Reconstruction and Computer Simulations

The Illinois State Police Accident Reconstruction Team conducted acceleration tests using an exemplar vehicle driven in what was described as a normal manner, traveling from the point where most vehicles leave after securing the loads, and continuing through the crossing. The test vehicle, starting from a full stop, reached an average speed of 23 mph at the crossing gate in an average of 34.6 seconds. Using these data, the calculated average acceleration over that distance was .977 feet/sec^2.

The accident truck measured about 77 feet in length, and the distance from the west crossing gate to a clear point beyond the accident track was about 18 feet. Thus, if the truck were at the west gate, it would need to travel about 95 feet in order to reach a point where no part of it or its cargo intruded on the space required by the train. Tests indicated that, at a steady speed of 7 mph, the truck could have cleared the crossing in about 8.6 seconds. The Illinois State Police Accident Reconstruction Team attempted to determine the average minimum time for the accident vehicle to clear the accident crossing from a stopped position at the west crossing gate. In these tests, the exemplar truck accelerated across the entire crossing. Timing began when the truck started to move and stopped when the end of the overhanging steel rods passed the east crossing gate, a distance of about 118 feet. The exemplar truck took an average of 5.54 seconds to clear the crossing.

The Safety Board also conducted a computer simulation study to determine the estimated speed of the truck at impact, the relative position of the truck as it crossed the tracks, the amount of time it took the truck to traverse the crossing, and the timing of the signal activation. The simulation was also used to help determine whether the truck-tractor semitrailer could have safely stopped short of the crossing. A Human-Vehicle-Environment (HVE) system was used to conduct the computer simulation study. The HVE System is a software package that includes several programs used by the Safety Board to simulate certain aspects of the accident. The EDSMAC4 software program, for example, was used to simulate the accident dynamics between the train and the truck and the resulting trajectories at various initial speeds. The EDVDS software program was used to determine the truck's maneuverability as it approached the crossing. Several other programs were used to generate 3-dimensional computer models of various vehicles for the simulations.

The HVE system was used to conduct hundreds of simulation scenarios and to evaluate the effects of several variables. The simulations included the truck approaching at speeds of 7 mph to 19.6 mph in the right lane, straddling the centerline, and maneuvering into the left lane. The train was modeled as two locomotives, two locomotives and two cars, and as two locomotives and two cars with the entire weight of the rest of the train on the second car. The semitrailer was modeled to the end of the semitrailer and to the end of the steel rebar. The gates were modeled with the signals and gates working properly, with the signals and gates deploying late but clearing the tractor, and with the signals and gates working properly except for the nearside gate, which remains in the upright position until after the impact. Values such as the various surface frictions for the road, the crossing timbers, the tracks, and the grass, as well as the inter-vehicle friction during contact, were varied slightly.

The factors used to evaluate the relative merits of the individual simulations included how close to the actual values were the beginning of the simulated tire marks, the track of the tire marks, and the final rest positions of the truck tractor and the semitrailer. The simulation that best matched the physical evidence had the truck approaching at 15 mph, then slowing to 7 mph and maneuvering into the left lane before turning right across the crossing and heading for the right shoulder.

The EDSMAC4 simulations highlighted that the truck tractor's right front tire had to be off the right side of the pavement, beyond the crossing, at impact; that the truck's semitrailer and the train were at an 87.1-degree angle at impact; that the truck's left tire on the fourth axle had to be about 1 foot to the left of the centerline at impact; and that the tractor spun counterclockwise after impact. This was all validated with physical evidence. The Illinois State Police traffic crash reconstruction report stated:

> The furthest east point that the truck tractor reached was indicated by a tire print made in the dirt of the shoulder by the right steer axle. The furthest east point of the tire print was approximately four feet east of the actual tire at final position.

The report also stated:

> Viewing the tractor from the rear, a scrub mark was visible under the vehicle. The mark began at the south edge of McKnight Road and continued onto the shoulder through the dirt and gravel. The mark was not at a right angle to the roadway. Dirt and grade crossing stone was piled up on the side of and at the base of right tires on axle 2 and 3…. This scuff mark started as a 'V' just west of the west rail of the passing track, approximately one foot north of the centerline of the roadway….the trailer would have been at or near perpendicular to the IC crossing at the time of impact.

Since the road was at about an 8-degree angle relative to the tracks, the truck was at an angle on the road at impact as if turning right to avoid the descending far side gate or the train.

Results similar to the EDSMAC4 were obtained by another analyst using m-smac, another software program developed by a different software company. Both EDSMAC4 and m-smac were based on the Simulation Model for Automobile Collisions (SMAC), which was developed by the National Highway Traffic Safety Administration in the 1970s.

The approach of the truck to the crossing was simulated using the EDVDS software. EDVDS is used to model the vehicle dynamics of a commercial vehicle. Due to off-tracking (the tracking of the rear wheels inside the front wheels at low speeds), the truck had to be maneuvered into the left-hand lane and onto the left apron for the truck's fourth axle left tire to be a foot north of the centerline of the roadway while the right front tractor wheel was off the right side of the pavement. When the truck straddled the centerline, the truck's fourth axle left tire was about 2 feet to the right (south) of where the tire mark was found.

Some of the other highlights of the simulations were as follows:

- At higher speeds, such as 15.6 mph, the EDSMAC4 simulations did not replicate the arch of the tire mark left on the crossing. The m-smac simulations could match the marks with changes in the weight of the train, vehicle inter-friction, and stiffness of the semi-trailer.
- If the truck straddled the centerline, the gates would have to be delayed for at least 9.9 seconds to clear the tractor's exhaust stack but not more than 14 seconds for the east gate to be down at impact and broken inward by the spinning rebar.
- In the most likely simulation, where the truck goes around the gate, the gates had no effect on the simulation, so the west gate could have been up or down.

Other Information

Emergency Preparedness

Local Agencies. The emergency management agency for the county in which this accident occurred was the Kankakee County Emergency Services and Disaster Agency (ESDA). According to ESDA officials, when a relatively minor emergency occurs, the local responding agencies, such as the Bourbonnais Fire Protection District, may control the incident scene with minimal or no assistance from the ESDA. When a larger emergency occurs that requires assistance from additional, nearby municipalities, the ESDA may provide increased assistance, including the coordination of communications and logistics. The ESDA provided such services to the emergency responders on the night of the accident.

The ESDA has developed several formal response plans to manage numerous aspects of response to various sorts of disasters (for example, chemical spills, hazardous materials accidents, etc.). The ESDA plan includes immediate response, incident command system (ICS) implementation, condition assessment, triage, delivery of emergency services, communications, and transportation of the injured.

The fire/rescue emergency service responsible for the location in which the accident occurred was the Bourbonnais Fire Protection District. According to the district officials, the agency is able, through mutual aid requests, to call on additional support from neighboring communities; it is also available to provide mutual aid assistance to other communities. A part of the Kankakee Valley Firefighter's Association (KVFA), the Bourbonnais Fire Protection District uses the formal documented fire/rescue emergency response plan organized and adopted by the KVFA. When implementing this emergency response plan, the Bourbonnais Fire Protection District employs a standard ICS to manage the on-scene response. Under the ICS, the chief of the department or a designated alternate serves as the incident commander, who has the overall authority and responsibility for all resources used in the incident response. The Bourbonnais Fire Protection District implemented the ICS in response to the accident, and the district chief was designated as the incident commander.

Before the accident, the ESDA organized and executed emergency response exercises simulating various event scenarios; the Bourbonnais Fire Protection District participated in these drills. The exercise scenarios in previous years had included one involving a railroad accident but not one in which passenger train equipment was involved. Critiques conducted following several of these drills identified significant problems with on-scene operational communications. Because these problems were not resolved before the accident, according to the Bourbonnais Fire Protection District chief, communications difficulties hampered the emergency response efforts at the grade crossing accident scene.

Amtrak. According to the requirements of 49 CFR 239.101(a)(5), every passenger railroad and every railroad hosting passenger train service must jointly adopt a single emergency preparedness plan describing the procedures to be followed in an emergency.

The regulation requires that each railroad organize a liaison with emergency responders in order to familiarize these emergency responders with the passenger railroad equipment, facilities, and communications interfaces.

In order to implement the emergency response liaison element of its emergency preparedness plan, Amtrak provides, upon request, an instructional information/training program for those local agencies most likely to respond to an Amtrak emergency. This training program includes training materials such as manuals and an instructional videotape. In addition, Amtrak offers on-site instruction sessions during which a representative of the railroad gives a training course directly to the local emergency response agencies. This training course is provided whenever possible. Amtrak, however, notes that it operates through regions that encompass about 15,000 emergency response agencies and that, because of limited resources, on-site training is not provided for all agencies that may be called upon to respond to an Amtrak emergency. For example, before the accident, Amtrak had not provided any on-site instruction or training to the Bourbonnais Fire Protection District or to other Kankakee County emergency responders. Amtrak did conduct passenger train emergency response training in Kankakee County, Illinois, after the accident, on November 12 and 13, 1999.

Current Status of McKnight Road Crossing

The Illinois Commerce Commission, in conjunction with the Village of Bourbonnais, has considered making improvements to the grade crossings at McKnight Road and at St. George Road, immediately to the north of McKnight Road. In October 2000, temporary highway signals were put in place at St. George Road and were interconnected with the railroad grade crossing signaling system. In addition, pre-signals, designed to stop highway traffic before reaching the crossing, were installed for eastbound traffic on St. George Road. Further improvements to St. George Road are planned, including relocating the crossing 500 feet east of the existing crossing to eliminate the need for traffic signal interconnection, widening the crossing, upgrading the crossing warning devices, and installing a barrier median at the crossing. Before agreeing to these changes, the Illinois Commerce Commission had an engineering diagnostic team evaluate the crossing. Costs for the relocation and reconfiguration of the St George Road crossing will be borne by the Illinois Department of Transportation. For the widening of the crossing and the upgrade of crossing warning devices, about $215,700 will be paid from the grade crossing protection fund, monies provided to the States by the Federal Highway Administration. Any additional costs, including the cost of future maintenance, will fall to the CNIC railroad.

According to the Illinois Commerce Commission, the Village of Bourbonnais is considering closing the McKnight Road crossing and running an access road to a nearby crossing, possibly St. George Road. According to the Township of Bourbonnais road commissioner, the closing of the crossing is a long-term objective. In the meantime, the township has installed temporary median barriers at the McKnight Road crossing.

Analysis

General

The Safety Board found no indication that the engineer at the controls of train 59 was acutely or chronically fatigued. Further, he successfully passed a physical examination 5 months before the accident. There were no problems with his vision or hearing based on a hearing and vision examination in September 1996. He stated that he had not used alcohol or drugs, including over-the-counter and prescription medication, before the accident. The engineer said that he was not overtasked/overworked on the evening of and before the accident, nor was he distracted or preoccupied before the accident. The event recorder recorded activities performed by the engineer showing the whistle being sounded, the throttle being manipulated, and the air brakes being applied on the train. These activities occurred continuously up to the point of collision.

The train crew satisfactorily performed the required pretrip tests of the train and reported no deficiencies, nor did they report any problems during the operation of the train. In addition, postaccident testing revealed no track defects in the accident vicinity, and crewmembers did not mention track conditions as a concern. The Safety Board tested the train's air brakes and reviewed equipment maintenance records for the 60 days before the accident. No defects were found that would have indicated that the equipment was impaired at the time of collision.

The mechanical subsystems on the semitrailer could not be tested. The individual components were tested or examined, however, to determine their condition and to determine compliance with the applicable Federal regulations. No discrepancies in the brake system, the suspension system, or the tires were noted. The truck tractor did not receive any collision damage, and postaccident inspection and testing revealed no discrepancies with the steering, suspension, chassis, powertrain, drivetrain, tires, or brake systems on the tractor.

The National Weather Service in Chicago, Illinois, reported unrestricted visibility at 10 statute miles and no precipitation at the time of the accident. The temperature was reported to be 33° F. The train engineer and other witnesses indicated that visibility was good, other than the darkness of the night. The cool temperatures were not mentioned as having an effect on the accident.

Postaccident drug and alcohol testing of the truckdriver was conducted by the motor carrier in accordance with Federal requirements. The results of these tests were negative for illicit drugs and alcohol. Further analysis of the driver's blood and urine revealed the presence of prescription medications and nonprescription medications. These drugs either have not been shown to have adverse effects on performance or were taken more than 24 hours before testing.

Although no speed studies were available for McKnight Road, the postaccident testing established that a truck could reasonably be expected to reach about 23 mph when approaching the crossing after leaving the parking lot. For a crossing with an estimated 85th percentile approach speed of 25 mph, the MUTCD recommends that the highway/rail grade crossing circular advance warning sign (W10-1) be placed a distance of 250 feet before the crossing. For stop or deceleration conditions, the distances are even less. The circular advance warning sign for eastbound traffic at McKnight Road was 512 feet away. The 320-foot distance of the railroad crossing sign on the westbound approach from the most easterly rail is also excessive when the MUTCD criteria are applied. Also, in that location, the sign was only 70 feet from the westerly curb line of the nearest intersection, Route 50, a “T” intersection. At this distance, the driver of a turning vehicle hardly has sufficient time to recognize the sign. A sign placed closer to the crossing should be more effective in alerting a driver to the crossing. However, most drivers using this highway are probably aware of the crossing and the sign primarily serves as a reminder to them.

The Safety Board therefore concludes that the following factors did not cause or contribute to the accident: the physical condition or actions of the engineer of Amtrak train 59; the mechanical condition of the train and the condition of the tracks; railroad operating procedures and policies; the mechanical condition of the truck-tractor semitrailer; the equipment making up Amtrak train 59; weather; alcohol, drugs, or prescription medications; and the location of traffic control signs on the approach to the grade crossing.

Truckdriver Performance

The truckdriver stated that as he approached the grade crossing on the night of the accident, he saw the crossing signal lights illuminate. He said that because of his proximity to the crossing when the lights activated, he had to quickly choose a course of action from several options available to him: (1) he could brake hard and stop short of the crossing but risk a dangerous load shift, (2) he could brake moderately and prevent the load from shifting but risk advancing too far and fouling the tracks, or (3) he could accelerate in an attempt to clear the tracks before the train arrived. In the truckdriver’s estimation, the best course of action was the last, to accelerate across the tracks before the train arrived.

The truckdriver, therefore, maintained that the amount of time between activation of the signal lights and the arrival of the train was insufficient to permit him to clear the crossing. Staff reviewed the driver’s testimony, and all of the postaccident tests and analyses, to determine if the preponderance of evidence supports the driver’s contention, or if an alternative scenario could explain the actual events leading up to the accident. Specifically, staff examined some of the key facts reported by the truckdriver, including: the truck’s speed before the collision; the truck’s distance from the tracks when the red crossing lights first came on; the operation of the crossing lights and crossing gate; and the time that the driver first observed the crossing lights.

Truck Speed

According to the truckdriver, his vehicle was in sixth gear and traveling about 20 mph at the time of the collision. The Illinois State Police Accident Reconstruction Team conducted acceleration tests using an exemplar vehicle driven in what was described as a normal manner, traveling from the point where most vehicles leave after securing the loads and continuing through the crossing. The test vehicle, starting from a full stop, reached an average speed of 23 mph at the crossing gate in an average of 34.6 seconds. Using these data, the calculated average acceleration over that distance was .977 feet/sec^2. If the accident vehicle was operated in the same manner as the test vehicle, then the speed cited by the truckdriver is consistent with the test results. In testing conducted by the Illinois State Police, it was not possible to negotiate a similar truck around the gates at speeds in excess of 15 mph.

Statements by two eyewitnesses, however, suggest that the accident truckdriver applied his brakes while on the approach to the crossing. The truckdriver who was putting a tarpaulin on his load in the parking lot stated that he heard the accident truck's jake brake as it rolled by him on the roadway and that he saw the truck's brake lights come on. In addition, the motorist who pulled out onto the roadway following the truck stated that he saw the brake lights on the truck illuminate as the truck approached the crossing. In his statement at the Safety Board's public hearing, this witness also estimated that the truck's speed before reaching the crossing was about 7 mph.

Pivoting around its fifth wheel connection upon impact, the semitrailer left tire marks on the pavement and rail. The Safety Board used data about the location, angle, and length of these tire marks to provide a benchmark for the validity of its computer simulations. When the simulated truck was run at various speeds, the simulated tire marks created were compared with the locations of the real ones, and the final rest position of the simulated truck was compared with the truck tractor's actual final rest position. Two analysts used differing software to generate the simulations; both came up with similar results. Based on these simulations, it was determined that the existing tire marks were more likely to have been left by a vehicle traveling between 7 and 14 mph, not 20 mph.

Based on both the eyewitness testimony and the simulation analyses, the Safety Board concludes, therefore, that the accident-involved truck-tractor semitrailer was probably traveling between 7 and 14 mph at the time of the collision.

The crossing warning signal system was programmed to activate about 26 seconds before the arrival of a train at the crossing. If the truck had been approaching the crossing at an average speed of 7 to 8 mph, it would have been about 284.5 feet from the crossing 26 seconds before impact. At 14 mph, the truck could have traversed more than 500 feet in 26 seconds; this would place the truck near the driveway from which it entered McKnight Road. The speed of the accident truck undoubtedly varied as it accelerated, then braked on its course down McKnight Road, and, therefore, the truck was likely to be somewhere between 285 and 500 feet from the crossing when the lights were programmed to begin flashing.

Warning Signal System Activation

The only scenario under which the time from activation of the warning signals until the arrival of the train would not have allowed the truckdriver to either stop his truck short of the crossing or accelerate safely across would involve some malfunction of the signal warning system. A malfunctioning system that first activated when both the train and truck were close to the crossing, for example, could conceivably place a driver in a situation in which, regardless of the speed he was traveling, he would not be able to take measures to prevent the accident. However, as discussed previously, postaccident testing of the lights found no evidence that they were not operating as designed.

Statements made by eyewitnesses to the accident, however, raised the question of whether the grade crossing signal worked as designed. According to the accident-involved truckdriver, the lights began flashing just as he reached the crossing. He also indicated that he did not believe he could safely stop the truck before reaching the tracks, and therefore he accelerated in an attempt to get the truck across the tracks. The motorist who followed the accident truck stated that he also thought that the lights began flashing just as the truck reached the crossing, and added that the crossing gate came down on the back of the truck. The truckdriver in the parking lot indicated that he did not see the lights flash or the gates deploy. The security guard in the steel plant's scale house said he saw the lights flash about 5 seconds before the train's arrival at the crossing, and his wife, who was visiting him, stated that when she first noticed the lights flash, she thought the truck's cab was on the crossing.

In an attempt to determine the relative accuracy of these eyewitness accounts, the Safety Board reexamined the function of the grade crossing signaling system and studied the vehicle dynamics to determine whether the collision could have occurred as they indicated.

Based on accident reconstruction scenarios, a truck of the kind involved in this accident, traveling at a steady speed of 7 mph, could have cleared the crossing in about 8.6 seconds. Tests in which an exemplar truck was stopped at the west gate and then accelerated across the crossing showed that the truck could have completely cleared the crossing in an average of 5.54 seconds. If, then, the warning signals at the crossing provided the designed 26 seconds of warning time before the arrival of the train and if the truck had been at the approach to the crossing when the signals activated, the truck would have had more than ample time to successfully traverse and clear the crossing.

Although recollections of some witnesses seemed to indicate that the signal activation may not have occurred sufficiently in advance of the arrival of the train, several factors suggest that those recollections may not accurately reflect the timing of the event. First, the crane operator said he saw the signal lights flashing before he turned to complete a task that was verified to require about 15 to 20 seconds. He said that when he finished the task and looked back at the crossing, he saw the collision. These statements suggest that the flashing lights provided more warning time than the truckdriver and other witnesses said they remembered.

Secondly, the on-scene testing of the signal system found no evidence of a failure in the electronic components of the system. And, finally, the event recorder for the signal system indicated that the signals did indeed provide about 26 seconds of warning time. The recorder was tested on-scene, then removed and tested at the manufacturer's facility. The laboratory testing showed that the recorder was operating within the parameters specified for a newly manufactured product; this suggests that the events were recorded accurately and that the GCP 3000, the computer governing the timing of the signal activation, functioned as designed. The Safety Board concludes, therefore, that the grade crossing signal lights began flashing at least 26 seconds before the train's arrival at the McKnight Road grade crossing.

Crossing Gate Operation

Crossing gates typically begin to lower within 4 to 5 seconds after the warning lights activate. Although data downloaded from the signal system event recorder for the accident crossing showed that a lowering of the gates was initiated, the information captured by the event recorder does not include the actual position of the gates. Investigators therefore conducted a number of tests to determine whether, in this accident, a failure or delay occurred in the lowering of one or both gates.

Investigators examined the circuit diagrams for the gates to determine what could cause both gates to be delayed or prevented from lowering while the lights are flashing. Two possibilities were considered: (1) failure within the gate control circuit, or (2) simultaneous failure of the motor control relay in each gate arm mechanism. Maintenance and inspection records for this crossing's signals show no indications of a history of failure within the gate control circuit. In addition, the on-scene field testing conducted following the accident revealed no problems with the gate control circuit, and the XRPR relay on that circuit functioned normally in cutting power to the motor control relays that hold the gates in the upright position. Any failure of both gates, therefore, would have required the simultaneous failure of two separate motor control relays that did not have a history of failure and that functioned normally in postaccident tests. Finally, the pattern of breakage evident on the tip of the east (far side) gate is consistent with that gate having been fully down at the time of impact.

With a simultaneous failure of both gates to lower properly thus ruled out, investigators examined a failure mode in which the lights activate at the appropriate time but one gate (in this case, the west, or approach side, gate) fails to deploy. According to the circuit diagram, in order for this to happen, a failure within only one of the gate arm mechanisms would be required.

According to downloaded signal event recorder data, the GCP 3000 warning signal system computer detected the presence of train 59 at 9:46:59 p.m. Four seconds later, the XRPR crossing control relay de-energized, which in turn de-energized and opened both gate motor control relays. When these relays open, power is removed from the gate hold-clear mechanisms and the gates are released. At that point, if the gates are operating normally, the gate motor activates to control the gravity-assisted descent of the gates.

Laboratory testing of the west (approach side) gate arm mechanism revealed no sign of improper operation; nevertheless, investigators recognized that some latent or intermittent defect could still exist within the mechanism. The Safety Board therefore conducted laboratory examinations of the mechanical and electromechanical components of the west gate arm mechanism to determine whether such a failure could be detected.

Motor Control Relay. If, for any reason, the motor control relay within the gate arm mechanism was not de-energized or if once de-energized, it failed to open, the gate motor would not receive power, nor would the hold-clear mechanism release the gate. The data downloaded from the signal event recorder indicated that the gate motor for both gates did energize. If for any reason the energized motor had then failed to operate, the gates would still have descended by gravity once the hold-clear mechanism released. The fact that the gate motors did energize indicates that the motor control relays functioned as designed. Also, operational tests showed that the motor control relay for the west gate functioned as designed. The electrical test showed that the operating parameters of the damaged relay were still within limits specified for new equipment, and the mechanical teardown found no evidence of foreign material transfer that might have caused the relay to stick when de-energized.

Bearings. The main shaft bearings bore Brinell marks or indentations indicating that at some time the bearing components struck one another with considerable force. When the marks on the inner race, which is affixed to the shaft, were lined up with the marks on the outer race, which is affixed to the outer casing, they indicated that the gate was in a fully upright position (in regard to the relative positions of the gate and the shaft) when the marks were made. Thus, if it could be determined conclusively that the Brinell marks occurred as a result of this accident, the orientation of the marks could serve as evidence of the gate position at the time of the collision.

The indentations found on the signal mast base clearly show that, during the course of the collision between the train and the truck-tractor semitrailer, a bundle of rebar struck the signal mast. This secondary impact was severe enough to move the entire mast, as well as the concrete foundation to which it was bolted. Additionally, the impact fractured the cast metal base of the pole. Much of the impact energy to the base was most likely absorbed by the impact-induced fracture of the base and pole mounting. Laboratory analysis of both the wooden gate arm and the cast metal counterweight arm fracture surfaces suggest that they may have broken as a result of a vibratory flexural motion that could have been induced by the impact to the base. While such motion could also have loaded the bearing, no clear evidence exists to indicate it could cause the Brinell marks observed on the bearing. The bearing races are fabricated from hardened steel. The pole is fabricated from a ductile alloy of significantly lower strength and hardness than the bearing races. Since the pole material at the bearing shaft interface showed no signs of permanent deformation or damage, it is not possible to conclude that any mechanism existed for transmitting enough impact energy from the pole to the bearing to cause the Brinell marks.

Several additional facts also make it impossible to declare positively that the Brinell marks were caused during the accident. First, Brinell marks can be inflicted on a bearing during installation if the bearing is dropped or stuck by a hammer or other object, or they may occur while the bearing is being pressed onto the shaft. Second, although the accident crossing had been equipped with crossing gates since 1968, records do not exist that would indicate whether the mechanism had been replaced one or more times before the accident or whether the mechanism that was in place on the day of the accident had received a blow from a previous accident or from another cause at any time before this accident. Third, because the mechanism was lifted, transported, and placed in an outside storage area where it lay for several months after the accident, the possibility that the damage occurred after the accident cannot be entirely discounted. Finally, although the impact to the base was sufficient to cause fracture of the counterweight arm, it is not known if the impact generated sufficient force in the proper direction to cause the brinelling damage to the bearings.

Gate Arm Light Bulb Filaments. The filaments of the accident-involved gate arm light bulbs were distorted in a direction parallel with the roadway. Investigators conducted tests on similar bulbs to determine whether the direction of this distortion could offer clues about the position of the gate at the time the filaments were distorted. These test results proved inconclusive as they showed that filament deformation in a given direction could come as a result of the filaments' being acted upon by forces from several different directions.

Driver's Actions. The Safety Board also considered the driver's actions as a possible clue to the functioning of the crossing gates. The driver stated that he did not notice the movement of the gates at the crossing (whether they were in the process of moving, or whether they were in an upright or down position) as he approached the tracks. According to the truckdriver, when he first saw the crossing lights flashing, he quickly decided to accelerate, and he focused his attention primarily on moving the truck straight ahead and across the tracks.

Computer simulations conducted by the Safety Board as part of this accident investigation provided evidence that disputes the truckdriver's account. As mentioned earlier in the discussion of the truck speed, two different analysts used different software programs to simulate the accident, generating hundreds of simulations. The simulations were not only used to estimate the truck speed, they were also used in an attempt to determine whether the physical evidence, particularly the tire marks, were more likely created by a truck driving more or less straight through the crossing with a delayed gate or by a truck driving around lowered gates. The analyses indicated that in order for the truck to have made the tire marks found at the scene, it must have been at an angle such that, at the time of impact, the right front tire of the tractor was near its final position and the left front axle of the trailer was to the left of the highway centerline.

Every highway vehicle experiences, to some degree, a phenomenon called offtracking, in which the rear wheels follow a shorter radius path than the front wheels when the vehicle is turning at low speeds. As noted earlier, the accident truck was likely moving at a relatively low speed (7 to 14 mph). Offtracking is of particular concern with longer vehicles, because the rear portion of the vehicle can strike roadside objects such as signs unless the driver compensates by swinging the front of the vehicle along a wider turning path. The simulations conducted by the Safety Board indicate that, when the offtracking characteristics of the accident truck are considered, the best fit of the observed data (most significantly, the tire marks) occurs when the truck tractor is moving toward the right-hand side of the road to recover from having been fully in the left lane. In other words, the simulations indicate that the data are best matched when the truck is driven as though to avoid lowered or lowering crossing gate arms.

To summarize, no repeatable malfunction of any of the gate arm mechanism's components, whether individually or in combination, was found during testing. Thus, the Safety Board was unable to reproduce any fault that would have caused a failure or a delay in the lowering of either crossing gate. The Safety Board therefore concludes that, based on the signal system tests and physical evidence, including evidence of the truck's position at the time of impact, both crossing gates likely lowered as designed as the accident truck approached the crossing.

Where highway/railroad grade crossing signal systems are equipped with event recorders, it is often possible to put in place a method to detect whether the gate has descended fully. The method of detection is sometimes as simple as an electrical contact made when the gate reaches the horizontal. Such a system may aid signal maintainers and inspectors, enabling them to see clear recorded evidence of signal malfunctions before accidents occur. However, the accident crossing in Bourbonnais was not equipped with a gate position detection system.

The Safety Board notes that all modern electronic warning signal systems may be equipped easily with signal event recorders and that almost all the warning systems installed as new or as upgrades by class I railroads are equipped with such devices. These recorders may or may not, however, capture the actual deployed gate position for those systems that are equipped with gates. For example, while all the warning systems installed or upgraded by the CNIC Railroad since 1995 have been equipped with signal event recorders, only after the Bourbonnais accident did the company specify that its newly purchased systems be required to capture gate position (horizontal or other than horizontal). According to CNIC officials, about 60 to 75 of the company's crossing signal event recorders now record this data. Some other class I railroads, notably the Burlington Northern/Santa Fe, also use event recorders that capture gate position information.[299]

In the view of the Safety Board, determination of actual crossing gate position is important not only because it facilitates accident reconstruction but also because it can help railroads detect and correct warning system defects or anomalies before they become a hazard to the public. While, as noted above, some railroads already recognize the benefits of gate position information and are installing event recorders that capture such data, other railroads are less aggressive in pursuing this option as they install new or upgraded systems. The FRA, while not requiring that grade crossing warning systems be equipped with signal event recorders, can nonetheless play a role in ensuring that those systems that are in place provide gate position information. The Safety Board believes,

[29] The Burlington Northern/Santa Fe Railroad event recorders that capture gate position indicate whether the gate is vertical (between 83 and 90 degrees) or horizontal (between 0 and 5 degrees).

therefore, that the FRA should, for all railroads that install new or upgraded grade crossing warning systems that include crossing gates and that are equipped with event recorders, require that the information captured by those event recorders include the position of the deployed gates.

In the interim, nothing prevents railroads that have not done so from following the lead of other carriers in regard to obtaining gate position information for those crossings equipped with new or upgraded warning systems that have both gates and event recorders. The Safety Board therefore believes that all class I and regional railroads should, for all their new and upgraded grade crossing warning systems that include crossing gates and that are equipped with event recorders, ensure that the information captured by those event recorders includes the position of the deployed gates.

Fatigue

The truckdriver customarily worked a 5-day work-week, Monday through Friday, delivering two loads of steel daily from the plant at Bourbonnais to Dayton, Ohio. These deliveries were accomplished within the Federal duty-rest requirements in effect at the time of the accident.

The driver reported that he was off duty for approximately 52 hours on Friday, Saturday, and Sunday, the weekend before the accident occurred on Monday evening. He reported receiving 2 full nights of sleep at home on both Friday and Saturday night, and about 2 hours, 30 minutes of sleep at home on Sunday evening. He awoke at midnight and reported for duty at 2:00 a.m. on Monday, the day of the accident, and delivered one load of steel to Dayton during the morning.

According to the reconstruction of the truckdriver's 72-hour history, following delivery of his steel shipment to Dayton, he loaded a shipment of forklifts in Canal Winchester, Ohio. He transported the forklifts to Peotone, Illinois, arriving at about 7:00 p.m. At this point, the truckdriver was not in conformity with Federal duty-rest requirements (discussed below). After unloading, the driver returned home.

In a revised statement, the truckdriver changed his initial account of the amount of sleep he had received on the day of the accident, reporting that he had slept for a total of 4 hours, 45 minutes, most in the sleeper berth but with a small amount of sleep at home immediately before the accident trip. Therefore, combining the 2 hours, 30 minutes, of rest the driver reported he received on Sunday night before reporting to work with the 4 hours, 45 minutes, he reported receiving on Monday would suggest that he accumulated 7 hours, 15 minutes, of fragmented sleep before the accident. A close examination of the various trip segments on Monday, however, suggests he had even less sleep. Based on Safety Board calculations of trip times and lengths, it is unlikely that the driver could have completed the majority of his trip in the amount of time he reported. The calculations indicate the trip would have taken about 1 hour and 45 minutes longer than the driver reported, thus allowing that much less time to sleep.

In addition, according to the accounts of the shippers and receivers of his trip loads, it appears that the truckdriver participated in the loading and offloading of his cargo, thus further reducing the time available for sleep. The amount of time needed to complete loading and offloading activities is not known, which prevents an exact determination of the amount of time the driver had for sleep on Monday. But based on all available evidence, the truckdriver accrued only 3 to 5 hours of fragmented sleep in the 38 hours (Sunday and Monday) before the accident.

Fragmented sleep, such as that experienced by the driver in this accident, has been associated with driver fatigue and a resulting decrease in performance. Research has shown that sleep accumulated in short time blocks is less refreshing than sleep accumulated in one long time period.[30] Safety Board research indicates that the duration of the most recent sleep period, the amount of sleep during the previous 24 hours, and split or fragmented sleep patterns are among the most critical factors leading to fatigue-related accidents.[31] As indicated above, the truckdriver's cumulative sleep total for the 24 hours before the accident was about 3 to 5 hours, well below the average of 6.9 hours slept by truckdrivers involved in fatigue-related accidents examined by the Safety Board. Truckdrivers involved in non-fatigue-related accidents averaged 9.3 hours of sleep within the previous 24 hours. The Bourbonnais accident-involved truckdriver's most recent sleep period lasted about 1 to 2 hours. In the Safety Board's study, the fatigue-related-accident truckdrivers had slept an average of 5.5 hours, and the non-fatigue-related-accident truckdrivers had slept an average of 8.0 hours in their most recent sleep periods before their accidents.

Research[32] has demonstrated how sleep loss is associated with decrements in decision-making, vigilance, reaction time, memory, psychomotor coordination, and information processing (for example, fixation on certain material to the neglect of other information). An operator may react slowly to information, may incorrectly process the importance of the information, may find decision-making difficult, or may make poor decisions. This performance degradation can be a direct result of sleep loss and the associated sleepiness and can play an insidious role in the occurrence of an operational incident or accident.

It is likely that the small amount of sleep the truckdriver had obtained resulted in decrements in one or more of the following: his decision-making, vigilance, reaction time, memory, psychomotor coordination, or information processing. These decrements may have caused the truckdriver to miss the onset of the grade crossing signal indication and to preclude his braking in time to avoid stopping on the tracks. Such an event is consistent

[30] Dinges, D.F., 1989, "The Nature of Sleepiness: Causes, Contexts, and Consequences," In: Stunkard, A.J.; Baum, A., *Perspectives in Behavioral Medicine: Eating, Sleeping, and Sex*, Hillsdale, NJ: Lawrence Erblaum Associates: 147-79, Chapter 9 (p. 147).

[31] National Transportation Safety Board, *Factors That Affect Fatigue in Heavy Truck Accidents*, Highway Safety Study NTSB/SS-95/01 (Washington, D.C.: NTSB, 1995).

[32] Rosekind, M., Gregory, K., Miller, D., Co, E., Lebacqz, V. *Analysis of Crew Fatigue in AIA Guantanamo Bay Aviation Accident*. Fatigue Countermeasures Program, Flight Human Factors Branch, NASA Ames Research Center.

with the driver's contention that the grade crossing warning lights did not activate until he was very close to the crossing and may have lead to the truckdriver's risky actions well after the warning system had actually been activated.

Despite the fact that the truckdriver was suffering from fatigue at the time of the accident, investigators could not determine the extent to which fatigue accounted for his performance. Investigators could, however, determine that at least some of the truckdriver's statements lacked credibility and that the accident did not happen exactly as the truckdriver described it.

As noted above, recorded evidence and the statements of the crane operator indicated that the signal lights began flashing more than 20 seconds before the arrival of the train at the crossing. If the signal lights had thus begun to activate just as the truck reached the crossing, as the truckdriver stated, he would have had more than enough time to clear the crossing, even if he had had to go around lowered or lowering gates to do so.

The truckdriver said he did not notice the position of the crossing gates. But eyewitnesses stated that the truck crossed the centerline of the roadway as it attempted to navigate the crossing. Also, computer simulations indicated that the truck, when struck, was moving from the left lane back into the right lane. This movement suggests either that one or both gates were down when the truck began to move over the crossing or that the truckdriver was anticipating the lowering of the gates and was maneuvering to avoid them when the collision occurred.

Based on all available evidence, the most likely scenario is that the signal lights began flashing as the truck was some distance from the crossing. The possibility exists that the truckdriver may not have noticed the flashing signal lights when they first activated. But the fact that those lights were seen by a crane operator who was as much as 600 yards away from, and at an angle to, the crossing makes it unlikely that they would have not been seen by the truckdriver only a few hundred feet away unless the driver was either sleep-deprived or distracted in some way. But according to witnesses, the truckdriver reduced throttle, which applied the jake brake, and he may have applied the brakes and further slowed, which suggests that he did, indeed, see the lights. At some point, as he continued to approach the crossing, the truckdriver made a judgment that he could clear the crossing before the train arrived. Perhaps he was misled by the normal delay in the lowering of the gates, or he may have assumed that the train was a slow-moving freight train rather than a passenger train.[33] Whatever the basis of the truckdriver's judgment and whether or not it was affected by fatigue, by the time the truck reached the crossing, most of the warning time had elapsed, and the arrival of the train was imminent. Considering the speed he was traveling and the length of his truck, the truckdriver had no chance to avoid a collision once he committed to attempting to cross in front of the train.

[33] The truckdriver was probably not aware that the signal system was designed to provide a fixed warning time regardless of the speed of an approaching train.

The Safety Board therefore concludes that the truckdriver had ample time to safely stop his truck and avoid an accident, but likely as a result of fatigue, he failed to respond appropriately to the signals and instead decided to attempt to cross ahead of the train.

Motor Carrier Performance

On the day of the accident, the truckdriver exceeded the work hours specified in the Federal Motor Carrier hours-of-service rules.[34] Since the truckdriver's last consecutive 8-hour off-duty period, he had been driving for more than 13 hours (10 hours are allowed) and had been on-duty for almost 20 hours (15 hours are allowed). Furthermore, at the time of the accident, the truckdriver was beginning another trip that would have put his duty/rest cycle even more out of balance and would have aggravated his already fatigued condition.

Originally, the Safety Board was led to believe that on the day of the accident, the truckdriver had transported the first load of steel and had returned home empty. According to this scenario, he was off duty at home and returned to work shortly before the accident to pick up his second load of steel of the day. Had this scenario been accurate, the driver would have been just within the hours-of-service rules, having driven for about 10 hours, then having about 8 hours of off-duty time before driving again. However, during the investigation, a back-haul was discovered. This back-haul load resulted in the driver's exceeding the hours-of-service limitation and led to his fatigued condition. Melco indicated that although it had scheduled the two loads of steel, the company was unaware of the back-haul. However, investigators found that the company (Country Supply) that arranged the load was closely associated with Melco, and loads similar to the accident back-haul load were frequently transported by Melco drivers, including the accident driver. Furthermore, Melco routinely billed Country Supply for the transportation services associated with those loads. Although Melco denied knowledge of the back-haul load, it appears that Melco probably knew about the load and may even have assigned it to the driver.

Unfortunately, investigators were unable to determine how the loads on the day of the accident were scheduled. Melco used assorted assignment and scheduling practices that are not uncommon among motor carriers that primarily employ owner-operators. Therefore, although Melco may have assigned all of the loads on the day of the accident, the Safety Board could not determine if the company was involved in scheduling the back-haul load for movement on the morning of March 15.

If the accident truckdriver self-scheduled the back-haul load without the knowledge of Melco, he could have done so with some confidence that its effect on his duty/rest schedule would not be noted by Melco, since weaknesses in Melco's driver oversight program made it unlikely that Melco would scrutinize the driver's duty status to monitor conformance with hours-of-service rules. Two days after the accident, a DOT

[34] Federal Motor Carrier Safety regulations, Part 395.3 Maximum Driving Time.

compliance review discovered that Melco had not kept duty status records for about half of its drivers, and this lapse was sufficient to result in an unsatisfactory rating for that category. Therefore the Safety Board concludes that Melco failed to provide driver oversight sufficient to detect or prevent driver fatigue as a result of excessive driving or on-duty periods.

Flammability of Interior Materials

The flammability of the interior materials of the sleeper car, including the floor and wall covering, seat upholstery, and cushion materials, was reviewed. The Safety Board evaluated two types of foam present in the seat headrests for flame spread and smoke generation. The white headrest foam, which is not in widespread use and is being phased out, met the requirements for smoke generation following 1 minute of testing but did not meet them after 4 minutes. The white headrest foam also did not meet the requirements for flame spread. The blue headrest foam, when tested with the Kevlar cloth cover normally attached in order to act as a fire barrier, met the standards for flame spread. The blue foam passed the smoke generation requirements at 1 and 4 minutes, even without the Kevlar cloth cover.

During the accident, the front half of the sleeper car was severely damaged by fire. The extensive fire damage was consistent with long exposure to high temperatures. Examination of the wreckage indicated that, following the collision, the front half of the car was in close contact with a fully developed pool fire that occurred when fuel spilled from the second locomotive ignited.

The remaining sleeper car half, where it was not collapsed too much to be assessed, showed little fire damage. There was some discoloration of the interior window surfaces, and slight sooting of the interior materials in the areas closer to the impact site in the middle of the car. Close to the impact area, there was evidence of burned interior materials. Because the evidence of fire damage was concentrated around the sections of the car exposed to the external fuel fire and was not spread generally throughout the car, the Safety Board concludes that the flammability and smoke generation properties of the train's interior materials did not contribute significantly to the spread of fire.

Emergency Response

The effectiveness of emergency response is affected by the preparations made by local jurisdiction responders and by the railroads involved. Because Amtrak is not able to provide on-site training to every emergency response agency within the territories through which it operates, these agencies often face the prospect of responding to a passenger train emergency without any real knowledge about the particular hazards passenger trains may present. In other words, local emergency responders may not know how to gain access to an overturned locomotive or passenger car, may not know where in cars to search for trapped occupants, and may not be aware of the quantities of diesel fuel available to fuel a fire. Before this accident, neither the Bourbonnais Fire Protection District nor other Kankakee County emergency responders had been provided on-site instruction or training in responding to such emergencies.

The Braidwood Fire Department officer, who arrived about 50 minutes after the first emergency responder, was familiar with petrochemical fires and recognized almost immediately that a large amount of foam was necessary to combat the blaze. Upon receiving concurrence from the incident commander, he called for heavy foam tanker trucks to come from a local chemical plant. The foam tanker arrived and was set up about 1 hour later, and within a few minutes of this equipment beginning to apply foam, the fire was extinguished. Before the arrival of the Braidwood officer, on the other hand, the incident commander had directed firefighting operations that had proved ineffective at either extinguishing the flames or at keeping the fire away from the sleeper car in which occupants were entrapped. The Safety Board concludes that because of insufficient training in responding to railroad emergencies or inadequate/inappropriate resources, or both, the Bourbonnais Fire Protection District was not prepared to respond effectively to a train accident involving a significant diesel fuel fire.

Even though modern locomotives, such as the ones involved in this accident, are designed with improved protection for fuel tanks, the possibility of a fuel leak and fire is present anywhere a major railroad accident occurs. The Safety Board believes that Amtrak, in fulfilling its Federal mandate to help prepare emergency responders to respond to an accident involving Amtrak equipment, should emphasize to those responders the possibility that such an accident could result in large quantities of burning diesel fuel and urge them to be prepared to respond to this specific hazard. The Safety Board further believes that the International Association of Fire Fighters and the International Association of Fire Chiefs should inform their memberships of the circumstances surrounding this accident and of the need for responders to prepare for train accidents that may result in significant diesel fuel fires.

Train Evacuation Effort

When the first Bourbonnais Fire Protection District personnel arrived at the accident scene, they saw that some 30 to 35 employees of Birmingham Steel had responded to the scene had begun the rescue effort. These steel plant employees had cut a hole in the chain-link fence separating the wreckage site from the steel plant's property and had brought a number of hand-held fire extinguishers and ladders from the plant to combat the flames. While some of the steel plant employees applied the fire extinguishers to the flames, others entered some of the damaged passenger cars to extricate entrapped passengers. These efforts were continued for an hour or more, when the steel plant employees were relieved by Bourbonnais Fire Protection District personnel, who continued the extrication efforts.

The Amtrak National Operations Center told emergency responders that the train could be carrying as many as 400 passengers. When Amtrak management arrived on scene, this number was lowered to 196. Several days after the accident, Amtrak identified the number of "confirmed" passengers to be 198. However, it was several more days before a complete list of passenger names was developed by Amtrak, and its accuracy remained in question. It was only later, when investigators were able to compare that list with a list provided by the Illinois State Police, that the correct passenger count of 207 could be determined.

The difficulty in determining the number of passengers involved may have put emergency responders at unnecessary risk. As the fire progressed, entry into some of the overturned cars became more hazardous, but rescuers repeatedly risked their own safety, returning to the cars in order to help the trapped occupants. They stopped only when the fire made it impossible for them to help any further. In some cases, rescue workers were able to identify locations where people were trapped. In other cases, however, because of the confusion over the number of passengers actually aboard the train, they may have been searching for unaccounted-for passengers who did not really exist.

Amtrak's passenger train emergency preparedness plan contained no elements addressing the need to provide an accurate count of train occupants to local emergency responders in the event of a passenger train emergency. Nor do the Federal regulations require such a section. As the confusion following this accident shows, however, the lack of a reasonably accurate count can lead to rescue personnel risking their lives needlessly.

In September 1994, the Safety Board published a report on its investigation into an Amtrak accident in Mobile, Alabama.[35] In this report, the Safety Board highlighted the value of providing emergency responders with an accurate count of train occupants, recommending that Amtrak:

> <u>R-94-7</u>
>
> Develop and implement procedures to provide adequate passenger and crew lists to local authorities with minimum delay in emergencies.

Amtrak responded with a plan to develop a satellite and long-distance messaging system between long-distance trains and corporate offices. One benefit of this proposed new communications system would be improved passenger manifests. Following a 1997 Amtrak accident in Kingman, Arizona,[36] Amtrak indicated to the Safety Board that such manifests were unlikely to become possible on unreserved trains, because of the many stops these trains make. The railroad did state, however, that computer systems exist that

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[35] National Transportation Safety Board, *Derailment of Amtrak Train No. 2 on the CSXT Big Bayou Canot Bridge Near Mobile, Alabama, September 22, 1993*, Railroad Accident Report NTSB/RAR-94/01 (Washington, D.C.: NTSB, 1994).

[36] National Transportation Safety Board, *Derailment of Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway near Kingman, Arizona August 9, 1997*, Railroad Accident Report NTSB/RAR-98/03 (Washington, D.C.: NTSB, 1998).

would enable them to provide such a list for reserved trains. As a result of these communications, the Safety Board closed the 1994 recommendation and issued a new recommendation urging Amtrak to:

> R-98-58
>
> Expedite the development and implementation of a passenger and crew accountability system on reserved trains.

Based on Amtrak responses in 2000, in which the railroad stated that it had implemented a system to account for all train occupants, the Safety Board classified this recommendation "Closed—Acceptable Action" in December 2000.

Roadway Geometry/Highway Condition

The wearing surface of the pavement was in good condition. The 5/8-inch to 1-inch depressed north shoulder indicates that there has been some use of the shoulder by vehicular traffic. This depression may have been caused by either railroad maintenance vehicles parking on the shoulder to service the signal bungalow in the northwest quadrant of the crossing or by large vehicles driving around lowered gates. According to tests conducted by the Safety Board and the Illinois State Police, an exemplar truck, loaded as the accident vehicle, would likely infringe on the shoulder area in the process of maneuvering around lowered gates. After the accident, the Illinois State Police took a tire print from this area; it did not match any tire pattern on any of the accident truck's tires.

Railroad pavement markings, consisting of an X, the letters "RR," certain transverse lines, and "no passing" double solid yellow centerlines, were required by the MUTCD; none of these were in place. One intent of pavement markings is to inform the motorist that he is approaching a railroad crossing. But the truckdriver, because of his experience on this route, was familiar with the crossing and did not need to rely on pavement markings. Therefore, the Safety Board concludes that the lack of railroad pavement markings probably had no effect on the truckdriver's driving behavior.

As a result of its investigation of a March 14, 1982, accident in Mineola, New York,[37] in which an impaired driver crossed the centerline to go around lowered gates and was struck by a Long Island Railroad commuter train, the Safety Board recommended that the Federal Highway Administration (FHWA):

[37] National Transportation Safety Board, *Long Island Railroad, Commuter Train/ Ford Van Collision, Mineola, New York, March 14, 1982*, Railroad/Highway Accident Report NTSB/RHR-82/02 (Washington, D.C.: NTSB, 1982).

> H-82-052
>
> Review the effectiveness of guidelines in the Manual on Uniform Traffic Control Devices (MUTCD) on the use of traffic divisional islands to deter motorists from driving around lowered railroad crossing gates.[38]

The FHWA responded that the subject would be covered in the *Railroad-Highway Grade Crossing Handbook* in 1984 (actually published in 1986). The handbook (a new edition is being prepared) states that "traffic divisional islands may be used at crossings on multi-lane roadways to prevent motorists from driving around a lowered gate." The recommendation was classified "Closed—Acceptable Action" in 1987.

The Swift Rail Development Act, passed in 1991, required that regulations be established to require that a train's horn be sounded on the approach to public highway/rail grade crossings except when supplemental safety measures fully compensate for the absence of audible warning, when there is no significant risk to persons, or when it is not practical (as is the case during certain backing movements). In response to the Swift Act, on January 13, 2000, the FRA published a notice of proposed rulemaking (NPRM) entitled "Use of Locomotive Horns at Highway-Rail Grade Crossings." In this NPRM, the FRA indicates that the supplemental safety measures that would be considered adequate would include (1) four-quadrant gates, (2) medians or channelization devices at gated crossings, (3) paired one-way streets, (4) temporary crossing closure (for example, crossing closed at night), or (5) the use of photo-enforcement technology. The NPRM also indicated that in addition to the supplemental safety devices, all crossings within a quiet zone had to be equipped with train-activated lights and gates. The period for comments on the NPRM closed May 26, 2000; the FRA has received more than 2,300 comments. To give the public an opportunity to provide oral comments, the FRA also conducted a series of public hearings on the matter in California, the District of Columbia, Florida, Illinois, Indiana, Massachusetts, Ohio, and Oregon. According to the FRA's Office of Safety, the rule is expected to be completed by spring 2002.

Given the reasons detailed above, the Safety Board is pleased to note that the Village of Bourbonnais has installed temporary median barriers in McKnight Road in the vicinity of the grade crossing until such time as the crossing can be closed.

Reducing Traffic Violations at Grade Crossings

The Safety Board is pleased to note the steps that have been taken in Illinois and nationwide to improve grade crossing safety through better enforcement of traffic laws at grade crossings. For example, not only do new Federal regulations promulgated in 1999 prevent States from granting a provisional, probationary, or other temporary license to a CDL holder whose CDL has been suspended, the new regulations require CDL suspension for a driver convicted of a grade crossing violation. Further, current Illinois State law

[38] The 2000 edition of the MUTCD states that channelization may be used between opposing lanes on all approaches when four quadrant gates are used.

provides that motorists convicted of grade crossing violations may be fined up to $500. In the case of CDL holders, both the fine and the potential loss of income (by CDL suspension) should provide an incentive for CDL holders to exercise greater caution at grade crossings.

But while greater penalties for grade crossing violations are welcomed, their deterrent effect can be undermined if motorists perceive that they face little threat of detection or apprehension. To address this problem, some States, localities, and other entities have developed innovative ways of approaching grade crossing enforcement. For example, Operation Lifesaver [39] organizations in several States have conducted programs to place law officers on trains and at stationary locations along the trains' routes. The officers at the stationary locations stop and ticket those motorists identified by on-board officers as having violated traffic control devices at crossings. While programs such as this can increase law enforcement awareness of grade crossing violations, in some States they are conducted only sporadically. As noted above, motorists who encounter what is, at best, limited and intermittent enforcement of traffic laws at grade crossings may conclude that it is possible to violate those traffic laws with some impunity.

To increase the likelihood that grade crossing violations will not go undetected, some States, municipalities, and railroads have turned to the use of photo enforcement at grade crossings. In use throughout the world for more than 40 years,[40] photo enforcement technology such as that used for identifying and citing those who run red lights has recently been adapted for use at grade crossings. In 1995, for example, the Los Angeles Metropolitan Transportation Authority (MTA) began a photo enforcement program that has been credited with reducing by almost 50 percent the number of grade crossing violations detected at 17 gated crossings along the Metro Blue Line route.[41] Encouraged by the program's success, the MTA is planning to expand its use of photo enforcement by installing six more crossing video systems during the first half of 2002.

A grade crossing photo enforcement pilot program has also recently been established in Illinois. The Illinois General Assembly in 1996 required the Illinois Commerce Commission to conduct a study of the effectiveness of photo enforcement at grade crossings. According to the commission, it selected three grade crossings in DuPage County, Illinois, for the test. Because of difficulties in establishing contracts, as well as construction problems, the three sites were completed at different times. Fully functional in January 2000, photo enforcement at the grade crossing in the city of Wood Dale achieved a 47-percent decrease in the number of violations between January and September 2000. This crossing, which had formerly experienced three to four collisions per year had only one collision in the pilot program's first 13 months of operation. Photo

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[39] Operation Lifesaver is a not-for-profit organization that provides information about grade crossing safety to motor vehicle operators, as well as to law enforcement agencies, through safety education programs.

[40] <http://www.photocop.com> is a non-commercial web site providing research and technical information about photo enforcement.

[41] Metropolitan Transportation Authority, *New Signs, Cameras Reducing Accidents, Illegal Crossings on Metro Blue Line*, MTA News <http://www.mta.net/press/stakeholders/scoop_stories/leftturn_trains.htm>.

enforcement at the grade crossing in the city of Naperville was functional in July 2000, and the crossing has seen a 51-percent reduction in the number of violations.

According to the FRA, the State of North Carolina has established, with Federal assistance, a program to eliminate grade crossing hazards as part of an attempt to develop a high-speed rail corridor within its borders.[42] Known as the Sealed Corridor Initiative, the program calls for the improvement or closure of every crossing along the proposed corridor. The plans include installation of four-quadrant gates, longer gate arms, and median barriers as well as video enforcement of grade crossing traffic laws. The testing of the video enforcement project has recently begun.

In the Safety Board's 1998 grade crossing safety study,[43] the Safety Board noted the sporadic nature of traffic law enforcement at passive crossings (those without train-activated warning devices). In order to promote better law enforcement at passive crossings, the Safety Board issued the following safety recommendation to the Secretary of Transportation:

> H-98-29
>
> Provide Federal highway safety incentive grants to States to advance innovative pilot programs designed to increase enforcement of passive grade crossing traffic laws.

After the DOT indicated that it had made inquiries to State and local law enforcement for suggestions regarding enforcement programs, the Safety Board classified Safety Recommendation H-98-29 "Open—Acceptable Response."

Whereas this recommendation was directed to enforcement at passive grade crossings, this accident, as well as subsequent violations recorded at the McKnight Road and St. George Road grade crossings, indicates that grade crossings equipped with train-activated warning devices could also benefit from innovative enforcement programs such as the photo enforcement programs employed in several locations. The Safety Board therefore believes that the DOT should provide Federal highway safety incentive grants to States to advance innovative pilot programs designed to increase enforcement of grade crossing traffic laws at both active and passive crossings. This recommendation replaces Safety Recommendation H-98-29, which has been reclassified "Closed—Superseded."

[42] <http://www.fra.dot.gov/o/hsgt/states/NC2.htm> on January 16, 2002.

[43] National Transportation Safety Board, *Safety at Passive Grade Crossings, Volumes I and II*, NTSB Safety Study Nos. NTSB/SS-98/02 (Vol. I: Analysis) and NTSB/SS-98/03 (Vol. II: Case Summaries) (Washington, D.C.: NTSB, 1998).

Conclusions

Findings

1. The following factors did not cause or contribute to the accident: the physical condition or actions of the engineer of Amtrak train 59; the mechanical condition of the train and the condition of the tracks; railroad operating procedures and policies; the mechanical condition of the truck-tractor semitrailer; the equipment making up Amtrak train 59; weather; alcohol, drugs, or prescription medications; and the location of traffic control signs on the approach to the grade crossing.

2. The accident-involved truck-tractor semitrailer was probably traveling between 7 and 14 mph at the time of the collision.

3. The grade crossing signal lights began flashing at least 26 seconds before the train's arrival at the McKnight Road grade crossing.

4. Based on the signal system tests and physical evidence, including evidence of the truck's position at the time of impact, both crossing gates likely lowered as designed as the accident truck approached the crossing.

5. The truckdriver had ample time to safely stop his truck and avoid an accident, but likely as a result of fatigue, he failed to respond appropriately to the signals and instead decided to attempt to cross ahead of the train.

6. Melco Transfer, Inc., failed to provide driver oversight sufficient to detect or prevent driver fatigue as a result of excessive driving or on-duty periods.

7. The flammability and smoke generation properties of the train's interior materials did not contribute significantly to the spread of fire.

8. Because of insufficient training in responding to railroad emergencies or inadequate/inappropriate resources, or both, the Bourbonnais Fire Protection District was not prepared to respond effectively to a passenger train accident involving a significant diesel fuel fire.

9. The lack of railroad pavement markings probably had no effect on the truckdriver's driving behavior.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the collision between Amtrak train 59 and a truck tractor-semitrailer combination vehicle at the McKnight Road grade crossing in Bourbonnais, Illinois, was the truckdriver's inappropriate response to the grade crossing warning devices and his judgment, likely impaired by fatigue, that he could cross the tracks before the arrival of the train. Contributing to the accident was Melco Tranfer, Inc.'s failure to provide driver oversight sufficient to detect or prevent driver fatigue as a result of excessive driving or on-duty periods.

Recommendations

As a result of its investigation of the March 15, 1999, grade crossing accident in Bourbonnais, Illinois, the National Transportation Safety Board makes the following safety recommendations:

New Recommendations

To the U.S. Department of Transportation:

Provide Federal highway safety incentive grants to States to advance innovative pilot programs designed to increase enforcement of grade crossing traffic laws at both active and passive crossings. (H-02-1)

To the Federal Railroad Administration:

For all railroads that install new or upgraded grade crossing warning systems that include crossing gates and that are equipped with event recorders, require that the information captured by those event recorders include the position of the deployed gates. (R-02-1)

To All Class I Railroads:
To All Regional Railroads:

For all your new and upgraded grade crossing warning systems that include crossing gates and that are equipped with event recorders, ensure that the information captured by those event recorders includes the position of the deployed gates. (R-02-2)

To the National Railroad Passenger Corporation:

In fulfilling your Federal mandate to help prepare emergency responders to respond to an accident involving Amtrak equipment, emphasize to those responders the possibility that such an accident could result in large quantities of burning diesel fuel and urge them to be prepared to respond to this specific hazard. (R-02-3)

To the International Association of Fire Fighters:

To the International Association of Fire Chiefs:

> Inform your membership of the circumstances surrounding the emergency response to the March 15, 1999, grade crossing accident in Bourbonnais, Illinois, and of the need for responders to prepare for train accidents that may result in significant diesel fuel fires. (R-02-4)

Recommendations Reclassified in This Report

To the U.S. Department of Transportation:

> H-98-29
>
> Provide Federal highway safety incentive grants to States to advance innovative pilot programs designed to increase enforcement of passive grade crossing traffic laws.

Safety Recommendation H-98-29, previously classified "Open—Acceptable Response" is reclassified "Closed—Superseded" in the "Reducing Traffic Violations at Grade Crossings" section of this report.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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Member

JOHN J. GOGLIA
Member

GEORGE W. BLACK, JR.
Member

Adopted: February 5, 2002

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Appendix A

Investigation

The National Transportation Safety Board was notified at 11:52 p.m., eastern standard time, on March 15, 1999, of a collision and derailment involving an Amtrak passenger train and a truck tractor-semitrailer combination vehicle in Bourbonnais, Illinois. The investigator-in-charge, Board Member John Goglia, and other members of the Safety Board investigative team were dispatched from Washington, D.C., headquarters, and from the Chicago, Illinois; Atlanta, Georgia; and Los Angeles, California, field offices. Upon arriving at the scene, investigative groups were established to study railroad operations, motor carrier operations, track, highway, signals, railroad mechanical, highway vehicle, survival factors, railroad human performance, highway human performance, locomotive event recorders, and hazardous materials issues. A separate group was established to coordinate the many witness interviews.

The Safety Board was assisted in the investigation by the Federal Railroad Administration, the Illinois Commerce Commission, the National Passenger Railroad Corporation, the Canadian National/Illinois Central Railroad, the Brotherhood of Locomotive Engineers, the United Transportation Union, the Bourbonnais Fire Protection District, the Illinois State Police, the Village of Bourbonnais Police Department, Melco Transfer, Inc., and Alstom Signaling, Inc.

Hearings

The Safety Board held a public hearing, chaired by Member George Black, in Chicago, Illinois, on September 13-15, 1999. Parties to the hearing included the Federal Railroad Administration, the Federal Highway Administration, the National Railroad Passenger Corporation, the Canadian National/Illinois Central Railroad, the Illinois Commerce Commission, the Brotherhood of Locomotive Engineers, the United Transportation Union, and Melco Transfer, Inc.