Collision of Burlington Northern Santa Fe Freight Train With Metrolink Passenger Train Placentia, California April 23, 2002

Railroad Accident Report

NTSB/RAR-03/04

PB2003-916304
Notation 7590

National Transportation Safety Board
Washington, D.C.

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Adopted October 7, 2003

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

National Transportation Safety Board. 2003. *Collision of Burlington Northern Santa Fe Freight Train With Metrolink Passenger Train Placentia, California, April 23, 2002.* Railroad Accident Report NTSB/RAR-03/04. Washington, DC.

Abstract: On Tuesday, April 23, 2002, about 8:10 a.m. Pacific daylight time, eastbound Burlington Northern Santa Fe Railway freight train PLACCLO3-22 collided head on with standing westbound Southern California Regional Rail Authority passenger train 809 on the No. 2 track at Control Point Atwood in Placentia, California. Emergency response agencies reported that 162 persons were transported to local hospitals. There were two fatalities. Damage was estimated at $4.6 million.

The safety issues discussed in this report are the attentiveness of the Burlington Northern Santa Fe train crew, the signal awareness form procedures for the Burlington Northern Santa Fe, passenger car survival factors, and the absence of positive train control systems.

As a result of its investigation, the National Transportation Safety Board issued safety recommendations to the Federal Railroad Administration, the Burlington Northern Santa Fe Railway Company, and the Association of American Railroads. The Board also reiterated a previously issued safety recommendation to the Federal Railroad Administration.

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Executive Summary

On Tuesday, April 23, 2002, about 8:10 a.m. Pacific daylight time, eastbound Burlington Northern Santa Fe Railway freight train PLACCLO3-22 collided head on with standing westbound Southern California Regional Rail Authority passenger train 809 on the No. 2 track at Control Point Atwood in Placentia, California. Emergency response agencies reported that 162 persons were transported to local hospitals. There were two fatalities. Damage was estimated at $4.6 million.

The National Transportation Safety Board determines that the probable cause of the April 23, 2002, collision of a Burlington Northern Santa Fe freight train and a Metrolink commuter train in Placentia, California, was the freight train crew's inattentiveness to the signal system and their failure to observe, recognize, and act on the *approach* signal at milepost 42.31. Contributing to the accident was the absence of a positive train control system that would have automatically stopped the freight train short of the *stop* signal and thus prevented the collision.

The safety issues identified during this accident investigation are as follows:

- Burlington Northern Santa Fe train crew attentiveness;
- Burlington Northern Santa Fe signal awareness form procedures;
- Passenger car survival factors;
- The absence of positive train control systems.

As a result of this accident investigation, the National Transportation Safety Board makes safety recommendations to the Federal Railroad Administration, the Burlington Northern Santa Fe Railway Company, and the Association of American Railroads. The Board also reiterates a previously issued safety recommendation to the Federal Railroad Administration.

Factual Information

Accident Synopsis

On Tuesday, April 23, 2002, about 8:10 a.m. Pacific daylight time, eastbound[1] Burlington Northern Santa Fe Railway (BNSF) freight train PLACCLO3-22 collided head on with standing westbound Southern California Regional Rail Authority (Metrolink) passenger train 809 on the No. 2 track at Control Point (CP)[2] Atwood in Placentia, California. Emergency response agencies reported that 162 persons were transported to local hospitals. There were two fatalities.[3] Damage was estimated at $4.6 million.

Accident Narrative

The crew (engineer and conductor) of commuter train Metrolink 809 reported for duty at 1:30 a.m. on April 23, 2002, in Riverside, California. (See figure 1.) The crew was scheduled to make several trips operating the same equipment but with varying train numbers during their tour of duty. They left Riverside at 2:55 a.m. on their first trip and arrived at Irvine sometime after 4:00 a.m. On the second trip, they departed Irvine at 4:23 a.m. and arrived at Los Angeles at 5:30 a.m. For their third trip, they departed Los Angeles at 5:45 a.m. and arrived back at Riverside at 7:05 a.m.

Meanwhile, the crew (engineer and conductor) of freight train BNSF PLACCLO3-22 (hereafter referred to by its operational identification, BNSF 5340) had reported on duty at Hobart Yard (near Los Angeles) at 2:30 a.m. on April 23. Between 2:30 and 5:30 a.m., the crew took charge of the assigned locomotives, coupled them to their train, and set out one defective car. By the time this was complete, several priority trains were ready for departure from Hobart Yard, and these trains were permitted to leave ahead of BNSF 5340. The conductor said that while he and the engineer waited for the traffic to clear, he took a 1 1/2 hour nap.[4] BNSF 5340 departed Hobart Yard about 7:30 a.m.

[1] Both BNSF and Metrolink designate timetable directions as east and west.

[2] A *control point* is a location where absolute signals are present and are under the control of a dispatcher or control operator. Trains may not pass absolute signals displaying *stop* without authorization.

[3] In order to provide standard classifications, the Safety Board applies published aviation injury criteria (49 *Code of Federal Regulations* 830.2) to all modes of transportation. For statistical uniformity only, an injury to a person that results in death within 30 days of the accident is classified a fatality. In the Placentia accident, a third injured passenger, a 77-year-old woman, died on or about June 7, 2002, which was about 45 days after the accident. Under the foregoing criteria, she is not classified in this report as an accident fatality. The Safety Board's investigation did not identify any evidence that her death was directly attributable to injuries sustained in the accident. Further, this classification does not reflect any determination that she did not, in fact, succumb to injuries received in the accident.

[4] *General Code of Operating Rules* Rule 1.11.1 allows napping by one of the crewmembers when the train is waiting for departure.

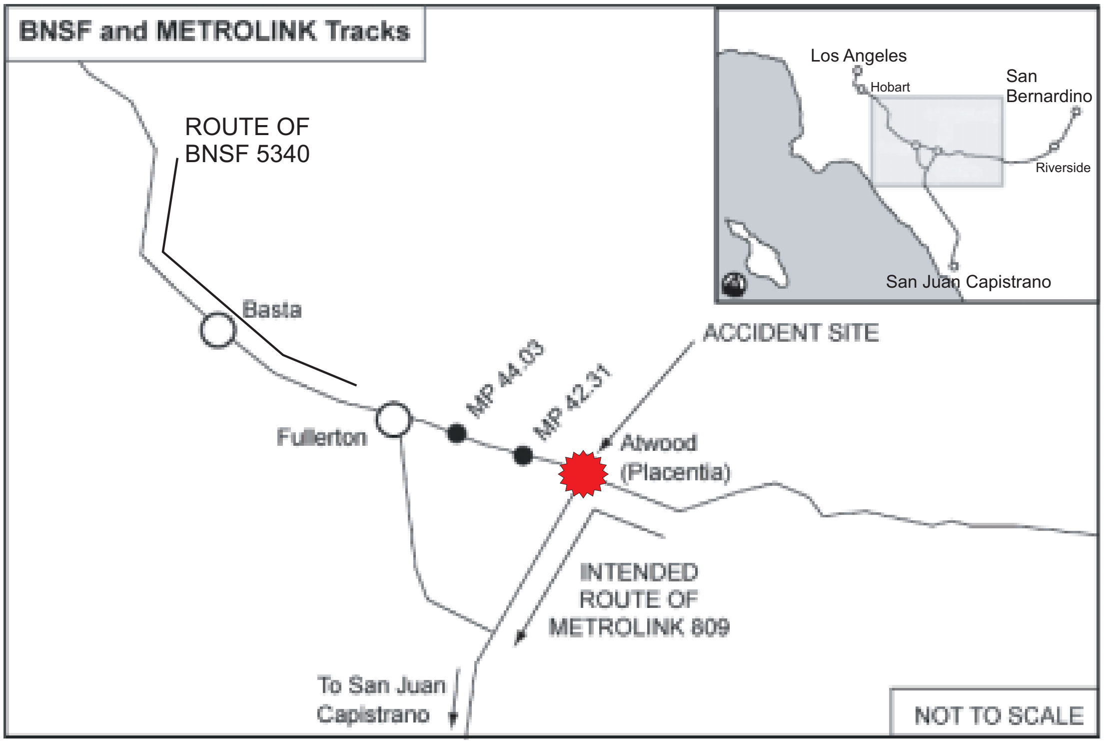

Figure 1. Accident location.

Between Hobart Yard and CP Atwood, the BNSF railroad is multiple-track territory with either two or three tracks. Trains may be operated in either direction on any of the tracks. The train dispatcher requests routes, and the traffic control system[5] moves track switches and displays signal aspects[6] to crews who operate their trains on the designated routes. BNSF 5340 changed tracks several times between Hobart Yard and Fullerton Junction as it negotiated the morning train traffic consisting of Metrolink and Amtrak trains.

At 7:32 a.m., the Metrolink crew, now operating their train as Metrolink 809, departed Riverside on their fourth trip of the day, heading for San Juan Capistrano. On this trip, the train was configured with the locomotive on the rear and the cab car on the front. The engineer was operating the train from a control compartment in the cab car. Approaching CP Atwood westbound, Metrolink 809 received a *diverging clear* signal to leave BNSF tracks and enter the Metrolink Olive Subdivision. (See table 1.)

[5] A t*raffic control system* (typically abbreviated "TCS") consists of wayside signals, powered switches, and control points. The dispatcher issues commands to the system to route trains on the desired tracks.

[6] The signal *aspect* refers to the physical appearance of the signal, which usually involves the display of colored lights, either singly or in different combinations. Although specific signal aspects vary not only by railroad, but sometimes across territories within a single railroad system, the names given to various signal aspects (*clear*, *approach*, *stop*, etc.) are generally uniform throughout the railroad industry and require similar responses from train crews.

Table 1. BNSF Track No. 2 signals as displayed at time of accident.

Location	Name	Aspect	Indication	Displayed to
MP 44.03	*Clear*	Green	Proceed	BNSF 5340
MP 42.31	*Approach*	Yellow	Reduce to 30 MPH prepared to stop at next signal	BNSF 5340
CP Atwood (eastbound)	*Stop*	Red	Stop	BNSF 5340
CP Atwood (westbound)	*Diverging Clear*	Red over Green	Proceed on diverging route at prescribed speed	Metrolink 809

Train BNSF 5340 was moving toward CP Atwood from the west. The engineer recalled that as he approached Basta, which is at MP[7] 163.0 (about 7 miles from C.P. Atwood), he received a signal that required him to slow his train to 30 mph, which he did. He said that he then noted that the next signal displayed approach but changed to clear before the train reached it. He then resumed normal operating speed.

The BNSF crewmembers said they were engaged in a conversation about previous employment; they had both worked at the same oil refinery before beginning their railroad careers. The BNSF 5340 conductor said that he called aloud the signal at MP 42.31—the signal before the signal at CP Atwood—as clear (refer to table 1) and that the engineer repeated "clear." According to the transcript of an interview that BNSF officials conducted with the conductor and engineer of BNSF 5340, the engineer acknowledged that he heard the conductor call out "clear" and that he "confirmed it." In a Safety Board interview, the engineer said that he did not see the signal. "My conductor called it before we went under it; by the time I looked up, we were past it." Both crewmembers said they approached CP Atwood thinking they were operating on a *clear* signal and that they thus were not required to stop or even slow the train. (According to data from signal system data loggers, the signal at MP 42.31 was displaying *approach* at the time BNSF 5340 passed.)

Both BNSF 5309 crewmembers said that just before the train reached CP Atwood, they realized that signal 4EA (MP 40.71) was showing *stop*.[8] The train was traveling about 49 mph at the time. (See figure 2.) They said they noticed Metrolink train 809 on the same track heading toward them, and the engineer placed the train brakes in emergency. The Metrolink 809 engineer said he was slowing the train preparing to go through a switch at 25 mph when he saw the freight train coming toward his train on the same track. He also placed his train in emergency, left the control compartment, and ran back through the lower level of the car warning passengers to brace themselves.

[7] BNSF milepost numbers increase from 0.0 at San Bernardino to 45.5 at Fullerton Junction. From Fullerton Junction, numbers decrease from 165.5 to 143.4 at Harbor Jct.

[8] The *approach* signal at MP 42.31 was intended to prepare the freight train crew to stop short of the *stop* signal at CP Atwood.

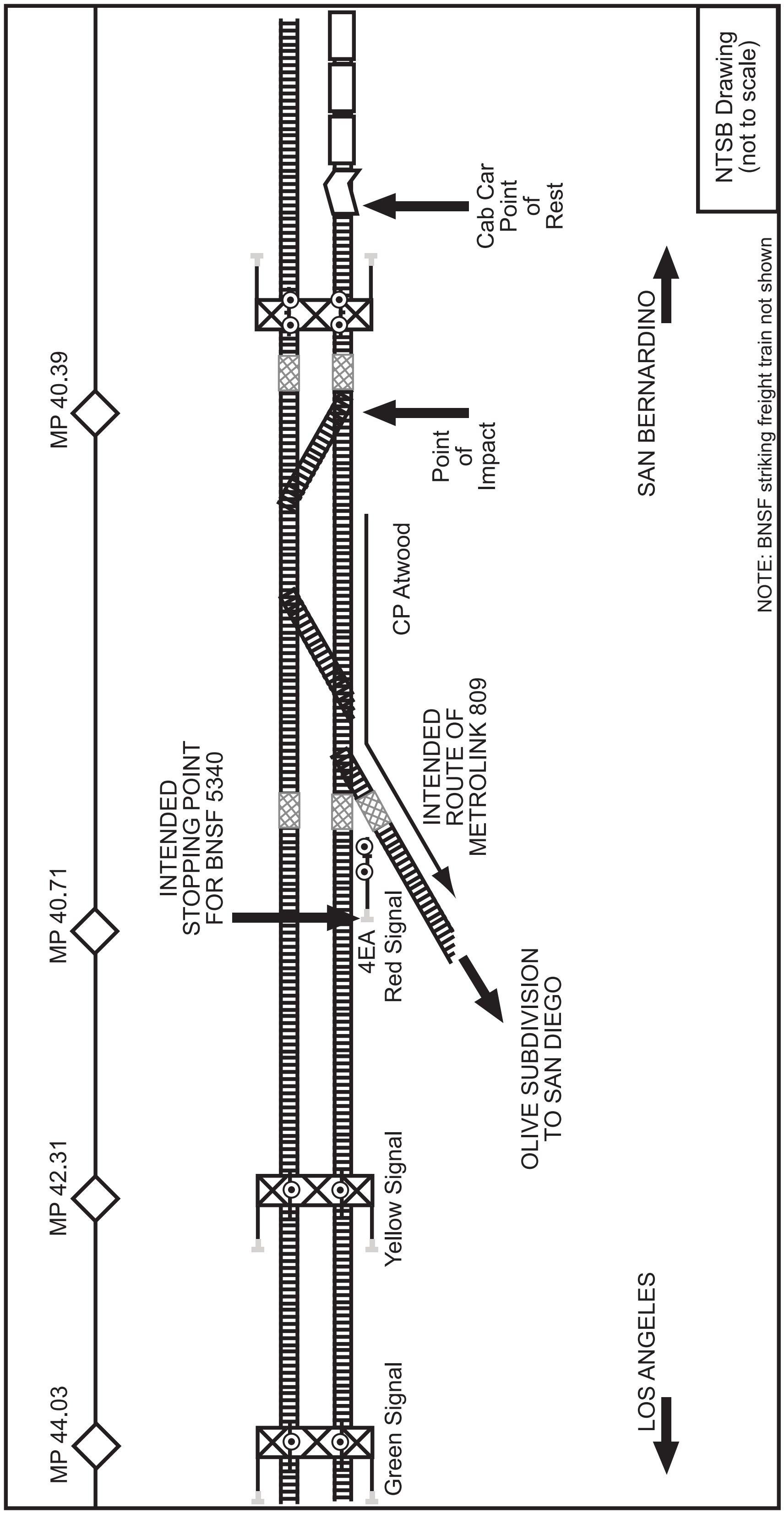

Figure 2. Signal System Layout

As the freight train slowed, the conductor jumped clear of the locomotive at approximately 25 to 30 mph. Soon after, the engineer also jumped clear. The train was traveling about 23 mph when it collided head on with the standing Metrolink train about 1,630 feet past signal 4EA.

A security surveillance video camera at a commercial storage facility adjacent to CP Atwood captured a portion of the collision on tape. The tape shows Metrolink 809 coming to a complete stop with the trailing (third) Metrolink passenger car standing in the center of the video camera view. After being stopped for about 12 seconds, Metrolink 809 is propelled backward as BNSF 5340 makes contact. The BNSF 5340 lead locomotive comes to rest in the center of the video image after both trains have stopped. Based on the known length of the Metrolink passenger cars and of BNSF locomotive 5340, the easterly movement of Metrolink 809 during impact was calculated to be about 243 feet. (See figure 3.)

Figure 3. Aerial photo of accident scene (courtesy Orange County Sheriff's Department).

Emergency Response

Fire and rescue emergency services for the city of Placentia are provided by the Orange County Fire Authority under a "joint powers agreement," which involves a network of municipality-based fire departments linked by a common county-wide emergency response dispatch system and management organization. The initial request for emergency assistance was a telephone call that was placed to the fire authority 911 communications center at 8:10:56 a.m. This was followed by numerous additional calls.

Orange County Fire Authority Division IV/Battalion 2 was the initial responding fire department agency[9] and was the principal responding fire/rescue emergency services agency in the accident. Other emergency services resources of Orange County simultaneously responded to the accident. Emergency response support was also provided by a large number of mutual aid response agencies as well as municipal and private ambulance services.

Ultimately, at least a dozen emergency response organizations and municipal support agencies were represented at the scene, including five fire department agencies and seven police agencies. A total of about 60 emergency response vehicles, 45 ambulances supplied by seven ambulance companies, and several motor coaches[10] responded to the scene. An estimated 120 emergency personnel, about 40 of whom were paramedics, responded to the scene. Also, medical trauma personnel (a physician and eight nurses) responded to the scene.

An Orange County Fire Authority chief served as the incident commander[11] during the emergency response and coordinated the combined activities of the various responding organizations.

The Metrolink cab car,. 634, sustained substantial crush damage and debris in and around the aft stairwell, which rendered the stairwell impassable. (See figure 4.) The stairwell provides access between the upper-level deck, the intermediate level, and the lower-level deck of the railcar (where the main doors are located). There is an intermediate level at each end of the railcar where an end door allows passage to an adjacent coach car. When the cab car came to rest, the aft end door was misaligned relative to the adjacent coach car. (See figure 5.) Emergency responders reported that those passengers on the intermediate level were able to remove the emergency exit windows without external assistance and were readily able to exit through the emergency exit windows and climb to the ground on ladders.

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[9] Division IV/Battalion 2 is the fire brigade resident to the city of Placentia.

[10] The motor coaches provided transportation to local hospitals for those identified during triage to have suffered minor injuries. Other buses were used, upon request, to transport uninjured passengers back to their initiating stations.

[11] The incident command system provides for the coordination of personnel, resources, and communication during the response to an emergency.

Figure 4. Damaged stairway in Metrolink cab car.

Figure 5. Damaged exterior of Metrolink cab car.

Emergency responders indicated that while passengers in the aft intermediate level of the coach were slightly delayed in exiting the railcar because of the damaged door, the passengers told responders that they were not injured or entrapped in any way. These passengers were also reported to have instructed the emergency responders to attend to the more seriously injured persons on the train until resources were available to assist them in exiting the car.

Emergency responders found two passengers who were showing minimal or no signs of life lying in the aisle of the upper deck of the lead Metrolink railcar. After a medical triage assessment was performed, one of these injured passengers, a 48-year-old male, was immediately transported by ambulance. The passenger expired in route and was pronounced dead upon arrival at the hospital. The other passenger, a 59-year-old male, was later pronounced dead at the scene.

Emergency response agency and medical facility records indicated that 264 persons on board the two trains were medically triaged at the scene. A total of 102 persons in the medical triage count were identified as "uninjured." In addition, one firefighter experienced dehydration at the scene and was transported to a local medical facility, which raised the medical triage count to 265 persons (which included the on-scene fatality). Of the 265 persons in the medical triage count, 162 persons received emergency transportation for medical assessment and/or treatment at local hospitals. This included 157 Metrolink passengers, 2 Metrolink crewmembers, 2 BNSF crewmembers, and the 1 injured firefighter. (See figure 6.)

Figure 6. Emergency responders treating accident victims.

Site Description

The BNSF San Bernardino Subdivision is part of the larger Southern California Division and runs in a timetable east-west direction between San Bernardino at MP 0.0 and Harbor Junction at MP 143.4. The San Bernardino Subdivision consists of multiple main track territory with sidings and crossovers. The maximum timetable[12] speed for trains operating through CP Atwood in the vicinity of the accident is 50 mph for freight trains and 60 mph for passenger trains. About 40 to 50 freight trains pass through CP Atwood each weekday, along with more than a dozen passenger trains.

The collision occurred on track No. 2 at BNSF milepost 40.39 on tangent track at CP Atwood. The point of collision was east of signal 4EA that governs eastbound movements on track 2 through CP Atwood. CP Atwood also controls movements to and from the Metrolink Olive Subdivision that connects Metrolink stations on the BNSF San Bernardino Subdivision tracks to stations along the Metrolink San Diego and Orange Subdivision tracks. In addition to the Olive Subdivision connector, there are two main tracks at CP Atwood, and trains can run in either direction on any track.

The general track construction at CP Atwood is a mixture of 119-, 131-, and 136-pound continuously welded rail fastened through tie plates to standard timber crossties supported by granite ballast.

Injuries

A review of hospital records for those Metrolink passengers transported from the scene indicated that the passengers stated to the medical staff that their injuries were sustained principally as a result of being thrown forward and striking some hard or unyielding surface or object such as a workstation table or seatback structure. (See table 2.)

[12] BNSF, Southern California Division Timetable No. 6, effective January 20, 2002.

Table 2. Injuries

Injury Type[a]	Employees	Passengers	Others	Total
Fatal	0	2	0	2
Serious	0	22	0	22
Minor	4	114	1[b]	119
None	0	122[c]	0	122
Total	4	260	1	265

[a] 49 *Code of Federal Regulations* (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."

[b] Responding firefighter treated for dehydration.

[c] Includes 102 persons who were medically triaged at the scene and identified as "uninjured" and released from the scene, plus 20 persons who were transported in the "minor" injury category to a local medical facility for which no medical records could be located (these persons apparently did not receive medical assessment or treatment and are thus not listed as injured).

Notations in several passengers' medical records indicated that they had informed the medical staff that one of the Metrolink train crewmembers in the cab car attempted to warn passengers of the impending collision just before the impact. The notations also indicated that several of those passengers were able to place themselves in positions or locations that they felt might have helped to reduce their injuries.

A review of the pathology reports on the two fatalities indicated that both persons received severe blunt impact trauma injuries to the chest and upper abdomen. These two fatally injured persons were found near seats 58 and 61 and 66 and 70, respectively, on the upper level of the lead railcar. They were apparently sitting next to each other on the right side of the aisle (relative to the direction of travel) in seats numbered 60 and 61, with both persons facing the direction of travel. (See figures 7 and 8.) These seats are about in the middle of the railcar and are a paired seating set arranged in an opposing (face-to-face) layout with another paired seating set (seat numbers 56 and 57), with a workstation table between them. The workstation table was found to have been pushed forward relative to its normal service location and was partially resting against the seatback of the opposite seat pair set. Although the table pedestal had not fully separated from its attachment to the floor, its attachment joint with the floor was bent and partially separated.[13] No one was identified as having been occupying seats 56 or 57 at the time of the collision.

[13] Emergency medical services personnel later needed to detach the table from the floor and wall in order to access the emergency exit window at that location.

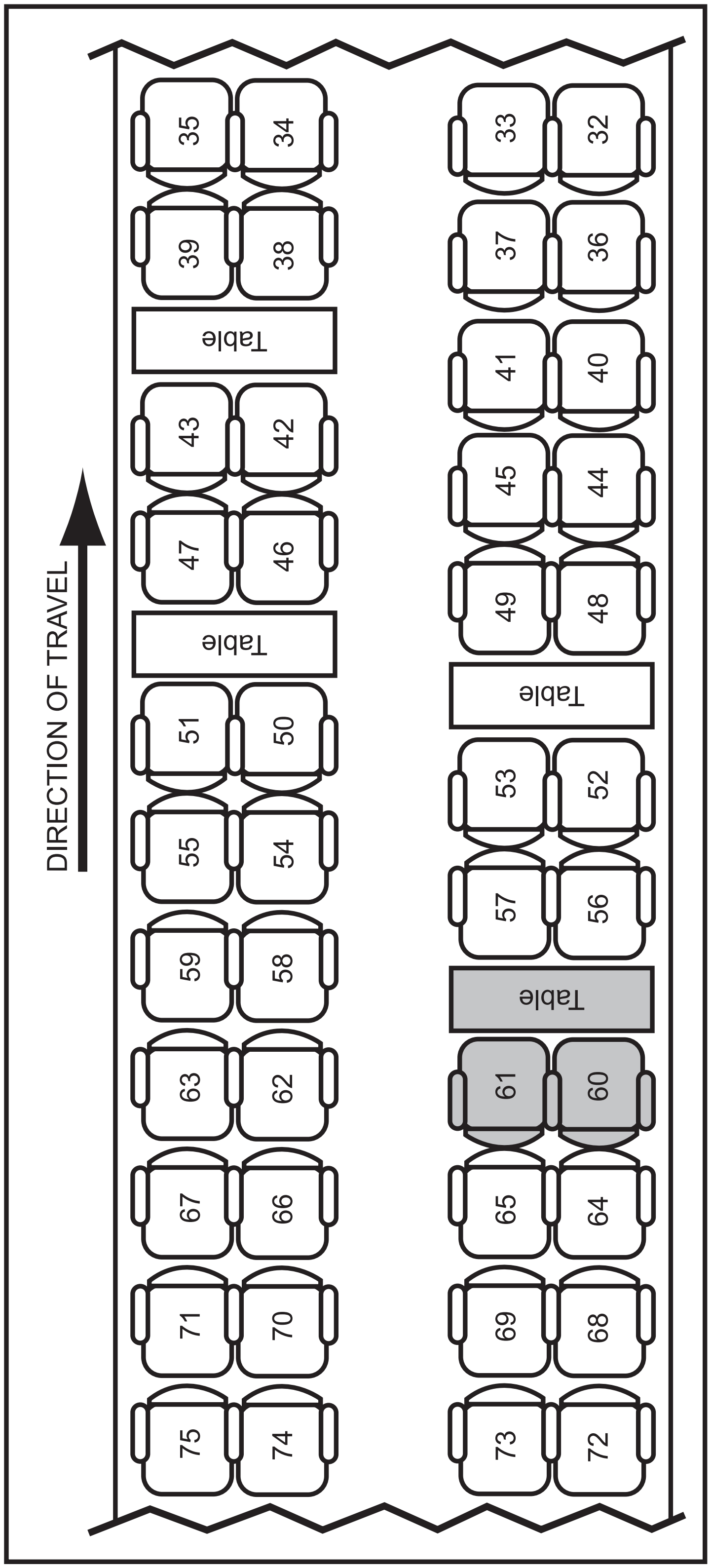

Figure 7. Seating layout of the upper-deck level of the Metrolink cab car. (Fatally injured passengers were seated in seats 60 and 61 at workstation table.)

Figure 8. Photograph depicting a simulation of the positions of the two fatally injured passengers relative to an exemplar workstation table. (The passengers were facing the direction of travel.)

Damage

Metrolink cars 634 and 113 derailed and sustained substantial crush damage. Metrolink estimated monetary damage at $4.6 million. BNSF locomotive unit 5340 sustained damage to the front end. BNSF estimated monetary damage to be $25,000.

Switch No. 3 on BNSF track No. 2 was damaged as a result of being run through (subjected to train movement that conflicted with the route for which the switch was lined) by the freight train. BNSF engineering personnel estimated the total track, structures, and signal equipment damages at $6,400.00. This figure included costs for the installation of a new switch point and stock rail.

Category	**Damages**
BNSF Equipment	$25,000
Metrolink Equipment	4,600,000
Track-Structures-Signals	6,400
Total	$4,631,400

Personnel Information

BNSF 5340

The engineer of BNSF 5340 was hired as a switchman in 1997. He was promoted to locomotive engineer on July 30, 1999. He had operated over the accident territory (Hobart to Barstow) for 1 1/2 years as a conductor and about 1 year as an engineer. He was due for engineer recertification training on July 30, 2002. His disciplinary record indicated that he received a formal reprimand for failing to stop short of cars on a yard track while working as a switchman in 1997. Otherwise, his record was clear.

The BNSF 5340 engineer was assigned to an extra board.[14] The day before the accident (Monday, April 22) he completed a 12-hour shift that began on Sunday at 4:00 p.m. and ended the next morning at 4:00 a.m. He said he then drove for an hour to his home, where he fell asleep about 5:30 a.m. and slept for about 10 hours. After waking, he remained at home, did some chores, and ate dinner. Afterwards, he said he took a nap for 2 1/2 hours until he was awakened by a phone call from the railroad at 11:30 p.m., during which he was told to report for duty at 2:30 a.m. He said he departed his house at 1:30 a.m. on April 23 and drove to the terminal. He told investigators that he felt "pretty good" when he departed Hobart Yard on the accident trip.

The BNSF 5340 conductor was hired as a switchman in 1998. He was promoted to conductor 3 months after being hired. His disciplinary record indicates he received a 30-day suspension in 2000 for failing to properly secure railcars, resulting in a collision with a motor vehicle. Otherwise, his record was clear.

The conductor was also assigned to an extra board. On the day before the accident (Monday, April 22), the conductor, after completing an assignment that had taken him to an away-from-home terminal, arrived at his hotel about 12:30 a.m. and slept until 7:45 a.m., when he was called by the BNSF to go on duty at 9:15 a.m. on April 22. He worked until 4:10 p.m. He said he spent time with his wife that evening, ate dinner, and slept from 9:00 p.m. until 11:30 p.m., when he was called to go on duty at Hobart Yard at 2:30 a.m. He said that after this call, he slept for another hour, then awoke and traveled to the terminal. He arrived at the terminal at 2:25 a.m. and went on duty at 2:30. The conductor said that although he felt tired when he reported for work, he felt "wide awake" when BNSF 5340 departed Hobart Yard.

Metrolink 809

The Metrolink 809 engineer was hired on August 24, 1992. He began operating Metrolink trains in September 1999. He received a favorable evaluation during his last locomotive engineer evaluation on January 18, 2002.

[14] An *extra-board* employee does not have an assigned job but is called as necessary either to substitute for a regular employee who is unavailable for duty or to serve as a crewmember on an unscheduled assignment.

The Metrolink 809 conductor began working in the railroad industry with the Atchison Topeka and Santa Fe Railroad in 1973 as a switchman/brakeman, and worked there until he was hired by Amtrak in March 1989. He began working on Metrolink[15] trains in September 1999.

Train Information

BNSF 5340

BNSF 5340 consisted of three locomotives and 27 loaded multi-platform intermodal freight cars (67 platforms total). The train weight was 5,755 tons. Records indicate that a mechanical inspection and an initial terminal air brake test were performed before the train departed Hobart Yard on the day of the accident. No exceptions were noted during this inspection and testing.

Metrolink 809

Metrolink 809 consisted of one locomotive and three passenger cars. At the time of the accident, the locomotive was at the rear of the train being controlled from the cab car at the front. This configuration, referred to as “push–pull” operation, eliminates the need to turn or switch equipment at the end of each run and allows quicker turnaround time at terminals.

Records indicate the Metrolink 809 was mechanically inspected and received an initial terminal air brake test before its departure from Riverside. No exceptions were noted during the inspection and testing.

The passenger cars on Metrolink 809 were bi-level coach cars manufactured by Bombardier Transportation, a division of Bombardier Corporation. The Metrolink railcar coach fleet comprises three groups[16] of Bombardier bi-level coach railcars identified by delivery series, number, and delivery dates, with the delivery of the individual groups occurring several years apart.

With regard to the design of interior features, the three groups of bi-level coach railcars are similar, with minor variants occurring between the delivery series. The design incorporates two full decks (an upper and lower) in the center of the railcar, with an intermediate-level deck situated over the truck assemblies at each end of the car. All three decks provide passenger seating. The bi-level coaches are all configured to the same basic passenger seating arrangement. The only significant difference between the coach/cab car and the coach/trailer is that an operator’s cab compartment is provided at the leading end of the coach/cab car. The Metrolink bi-level cab car and coach/trailer units have seating to

[15] Amtrak supplies the crews to operate Metrolink trains.

[16] These “groups” are also referred to (by both Metrolink and Bombardier) as “generations,” or “series.”

accommodate 142 and 149 passengers, respectively. Both coach railcar designs have a crush load[17] capacity of about 360 passengers.

Two stairwells in each Metrolink bi-level coach[18] provide access between the lower-level deck, the intermediate level at each opposite end of the railcar, and the upper-level deck of the railcar. Four main passenger ingress/egress side pneumatically operated pocket door sets[19] are on the lower-level deck of each railcar, with two sets of doors on each side. A vestibule area is provided between the main side-exit doors at each end of the lower-level deck. An emergency release handle adjacent to each main side-exit door may be used to release one of the sliding pocket door panels at each door location. A restroom is at one end of the lower-level deck. A door at each end bulkhead on the intermediate level provides passage to adjacent railcars.

Passenger seating accommodations on board the Metrolink bi-level railcars consist of a combination of transverse and longitudinal-mounted fixed seat assemblies,[20] with the seat assemblies installed on both sides of a longitudinally oriented center aisle passageway on all three deck levels. Almost all of the transverse mounted fixed seat assemblies in the Metrolink bi-level coach railcar fleet are arranged in a "2 + 2," paired/side-by-side configuration (also referred to as a "paired seating sets" arrangement). Many of the paired seating sets are arranged in an opposing face-to-face layout with the balance of the paired seating sets arranged so that the paired seating sets are all facing in the same direction.

Each Metrolink bi-level railcar is fitted with eight workstation tables, four on the upper level and two at each end of the intermediate level. These tables are fitted between paired seating sets of opposing passenger seats. The tables are a basic design consisting of a one-piece tabletop assembly that is cantilevered from and secured to the carbody sidewall. A single pedestal support leg is attached to the tabletop underside and is secured to the floor. The tabletops are trapezoidal in shape, approximately of a uniform size, and manufactured of a resilient plastic material.

Bombardier representatives said all of the bi-level railcars delivered to its customers have been fitted with the workstation tables and that the company had not conducted any biomechanical engineering analysis, testing, or injury causation assessment of occupant impact against the workstation tables.

Metrolink delivery series 200 and 207 railcars[21] have three exterior sidewall emergency access windows on each side of the upper-level deck. The lower-level deck has two emergency access windows on each side. A retro-reflective decal on the car exterior

[17] The c*rush load* is the maximum number of passengers that can possibly be riding in the railcar (standing and sitting).

[18] The stairwells are at approximately the 1/4 point and the 3/4 point along the length of the carbody.

[19] A *pocket door* is a door that opens by sliding horizontally into a narrow compartment within the wall adjacent to the doorway.

[20] A *fixed seat* is a passenger seat that is permanently configured in a given location such that it cannot otherwise be readily reconfigured (by operational or maintenance personnel) to face any other direction.

[21] These delivery series include railcars 113, 167, and 634, all involved in this accident.

near each upper- and lower-level emergency access window describes the emergency window removal procedure. The instructions are to use a screwdriver to pry out the seal (grommet) surrounding the windowpane. The decal also includes a grommet-removal pictorial and additional step-by-step instructions.

On the intermediate-level deck, all of the exterior sidewall windows could be removed by using an axe, a sledgehammer, or a similar impact tool to break the window glazing. Although emergency exit windows on the intermediate level had instructional signage and pull rings on the inside of the railcar, no instructional signage describing the window removal procedure was provided on the exterior sidewall near the intermediate-level deck windows, and such signage was not specifically required by regulations.

The upper- and lower-level decks of Metrolink delivery series 214 railcars[22] are fitted with the same exterior sidewall emergency access window configurations and exterior instructional signage as the series 200 and 207 cars described above. The intermediate-level deck windows can be removed without breaking the window glazing. Although not specifically required by regulation, intermediate-level exterior instructional signage was installed on this series of cars before the accident. The signage consists of a retro-reflective decal stating: "USE SCREWDRIVER TO PRY OUT SEAL SURROUNDING THE WINDOW PANE," along with additional step-by-step instructions.

Wreckage

The derailed Metrolink equipment came to rest substantially upright and somewhat in alignment with the track, although the aft end of the lead Metrolink railcar had skewed onto the adjacent track. The leading end of the Metrolink cab car,. 634, came to rest about 131 feet east of the Richfield Road grade crossing (centerline of the pavement). The lead BNSF locomotive 5340 came to rest lodged against the front bulkhead fascia of the Metrolink cab car.

Metrolink Cab Car 634

Metrolink cab car 634 had both its truck assemblies derailed, and the aft end of the railcar had skewed about 11 feet to the north. The carbody received relatively moderate impact damage to the front exterior and operator's cab. The aft end of the carbody structure was substantially damaged. The carbody in the vicinity of the aft stairwell was bent to the left (relative to the direction of travel) and displayed a 30° bend from its linear configuration. The aft end of the carbody was laterally displaced about 89 inches relative to its linear configuration, with the displacement point occurring about 178 inches from the aft bulkhead exterior fascia. Debris and crush damage rendered the aft stairwell impassable. There were no occupants reported in the stairwell area at the time of the accident. A section of the roof panel above the aft stairwell of the car had separated from

[22] None of which were involved in this accident.

its attachment and was buckled upward about 35 inches. A segment of the left sidewall panel near the aft stairwell of the car had been longitudinally displaced from its structural attachment. This resulted in a localized partial telescoping of the carbody sidewall panel structure in that area.[23] On the underside, severe damage was apparent on the structural steel center sill assembly.

On the interior, a number of the passenger seats and workstation tables throughout the railcar had shifted from their normal positions. Most of the emergency pull-windows had been removed.

Metrolink Car 113

The leading end of the second Metrolink car, 113, was lodged against the aft end of the lead cab car with its lead truck assembly derailed. A preliminary visual inspection indicated that the carbody received relatively little structural damage, with the damage principally confined to the exterior fascia panel of the front bulkhead, which had fractured in several places. A later, more extensive examination by Metrolink identified that the center sill (under-frame) structure at the A-end of the railcar was substantially damaged. In the interior, many of the seat cushions were dislodged from their attachments to the seats. There was no significant interior crush damage or a loss of occupant survival space in this car.

Metrolink Car 167

The leading end of the third Metrolink car, 167, was lodged against the aft end of the second railcar, and the aft end was coupled to the locomotive. This railcar had not derailed and was relatively undamaged during the accident.

Metrolink Locomotive 859

Inspection of Metrolink locomotive 859, indicated that the shank of the coupler at the leading end of the unit was bent. The locomotive was otherwise undamaged, and it did not derail.

BNSF Locomotive 5340

The lead locomotive of the freight train received minimal damage and did not derail, nor did the two other locomotives or any of the railcars in the BNSF train.

[23] The sidewall panel had separated from the structural framing and then was displaced (aft) when the carbody structure (aft of that location) pivoted to the left such that the sidewall panel came to rest overlapping the adjacent sidewall panel.

Operations Information

Train Dispatching

Train movements on the BNSF San Bernardino Subdivision and the Metrolink Olive Subdivision are governed by the *General Code of Operating Rules*, effective April 2, 2000, and by timetable instructions and the signal indications of a traffic control signal system. The train dispatcher at the BNSF control center in San Bernardino coordinates train movements with the signal system on the BNSF San Bernardino Subdivision. The BNSF train dispatcher controls CP Atwood and any diverging train movements between BNSF tracks and Metrolink tracks on the Olive Subdivision.

The BNSF traffic control system between CP Fullerton and CP Atwood (approximately 4.5 miles) consisted of three-aspect searchlight-type signals. With three-aspect signals, the aspect sequence encountered by a train approaching a red signal is green, followed by yellow, then red. A red signal is displayed to approaching trains when a track signal circuit is occupied by another train or under certain other conditions. Signals are arranged for train movements in either direction, are continuously lit, and are controlled by electronic coded track circuits.

Train Control

On the nearby Metrolink Orange and San Diego Subdivisions, an intermittent automatic train stop system has been in operation since the 1960s. This system was installed by the predecessor railroad (the ATSF) to allow 90-mph passenger train operations. (Without an intermittent automatic train stop or similar system in place, Federal regulations restrict passenger train speeds to a maximum of 79 mph.) In an intermittent automatic train stop system, wayside inductors transmit signal information to receiving equipment on Amtrak or Metrolink locomotives. Any signal indication other than *clear* requires an acknowledgement from the locomotive engineer. If the engineer does not acknowledge the signal indication within 7 to 8 seconds, the train's brakes will automatically apply.

The intermittent automatic train stop system does not enforce speeds; that is, as long as the engineer acknowledges a more restrictive signal, the system takes no other action, even if the requirements of the signal are ignored. Nor is the system fail safe: if an inductor is removed or inoperative, the system no longer requires an acknowledgement of a restrictive indication, and the wayside signal system does not automatically restrict train movement.

When Metrolink went into operation in the early 1990s, the signal system was renovated and spaced for cab signals.[24] Pole lines were replaced with coded track circuits, but locomotives were not equipped for cab signals, nor was any field equipment installed

[24] A *cab signal* system displays the governing signal aspect inside the cab of a locomotive so long as the locomotive is equipped to receive and display the signals and it is operating in territory equipped with a working cab signal system.

for cab signals. The Metrolink Orange/San Diego Subdivision intermittent automatic train stop system is the only such equipment on Metrolink tracks, and no cab signal systems are operative on the Metrolink system or on the BNSF San Bernardino Subdivision. The BNSF freight trains that operate over Metrolink tracks under trackage rights agreements are not equiped with automatic train stop receiving equipment and are limited by Metrolink to a maximum speed of 55 mph.

Signal Awareness Form

BNSF procedures required the BNSF 5340 conductor to enter the name/aspect of each signal encountered during the trip on a signal awareness form.[25] This form was recovered from BNSF locomotive 5340 after the accident. The first page of the form included the signals from MP 144.00 to MP 157.91. The train entered the territory at an intermediate point on the form, and the first signal encountered was at MP 146.98. The entry for this signal was "DA," meaning *diverging approach*.[26] This entry showed the speed and time (10 mph and 7:20 a.m.) as required by BNSF procedures. Some entries on the first page showed "A," indicating that the signals displayed *approach*. Several entries were "AM," or *approach medium*.[27] Most remaining entries had a "C," which the conductor explained meant *clear*. The second page contained the list of signals involved with the accident, from MP 159.48 to MP 40.71, the location of the *stop* signal.

The conductor explained that he always entered a "C" in this column as shown on the first page of the signal awareness form. Furthermore, the conductor explained that he did not always make an entry each time he observed a *clear* signal; he said he often waited either until an *approach* signal was encountered or until it was time to turn to the next page of the awareness form and then backfilled the entries for the *clear* signals up to that point.

The BNSF procedure requires that:

> All block signal names or aspects and yellow or yellow/red flags must be recorded. With the exception of CLEAR signals, which only require the name or aspect to be recorded, information must include the location of each flag, the train speed, time the signal or flag is passed and the name or aspect of the signal that was called. When speed indicator is not visible to the conductor, the engineer must call out the speed, in addition to the signal name or aspect, if other than CLEAR. Should the conductor be unable to record a signal aspect due to other activities, this fact must be noted on the form, including the reason.

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[25] The investigation determined that the Union Pacific Railroad also requires conductors to annotate signals on a special form, and the Norfolk Southern Railroad is considering such a requirement.

[26] Upon receiving a *diverging approach* signal, a train must "Proceed on diverging route not exceeding prescribed speed through turnout; approach next signal preparing to stop, if exceeding 30 mph immediately reduce to that speed."

[27] Upon receiving an *approach medium* signal, a train must "Proceed prepared to pass next signal not exceeding 40 mph and be prepared to enter diverging route at prescribed speed."

Calling Signals

The *General Code of Operating Rules* has a requirement for crew members to call signals.

The rule specifies the following:

> **Rule 5.16 Observe and Call Signals.** Crew members in the engine control compartment must be alert for signals. As soon as signals become visible or audible, crew members must communicate clearly to each other the name or aspect of signals affecting their train. They must continue to observe signals and announce any change of aspect until the train passes the signal.
>
> If the signal is not complied with promptly, other crew members must remind the engineer and/or conductor of the rule requirement. If the crew members receive no response or if the engineer is unable to respond, they must immediately take action to ensure safety, using the emergency brake valve to stop the train, if necessary.

During the investigation, the conductor described the signal at MP 44.03 (two signals in advance of Atwood) as the "first approach to Atwood" and said that this signal displayed green (*clear*).

The conductor said that he next called out the signal at MP 42.31 (one signal in advance of the *stop* signal at CP Atwood) as *clear*. The engineer stated that he remembered the conductor's calling this signal *clear*, but that he did not look at the signal himself.

Because of the location of Metrolink 809 and the settings in the train dispatcher's computer, the signal just before CP Atwood was displaying *approach*. Both the engineer and the conductor stated that the CP Atwood signal displayed *stop*.

Meteorological Information

At the time of the accident, the weather at Fullerton Airport (about 8 miles from CP Atwood) was reported as haze with a temperature of 58° F. The BNSF 5340 engineer stated that the weather at the time of the accident was clear and dry, with no smog or precipitation. Sunrise was at 6:11 a.m., and the altitude and azimuth of the sun at the time of the accident were reported to be 23.6° and 90.3°, respectively.[28]

Medical and Toxicological Information

The BNSF 5340 engineer's last company medical examination for vision and hearing was in the spring of 2002 as part of a required locomotive engineer recertification.

[28] Source: U.S. Naval Observatory <http://mach.usno.navy.mil/cgi-bin/aa_altazw>.

The examining physician indicated that he could operate in his current assignment with no restrictions. The engineer wore bifocals and said he was wearing them during the accident trip. The engineer indicated that he had not taken any medications during the 3 weeks leading up to the accident.

The BNSF 5340 conductor's last company medical examination was in 1998. The examining physician indicated that he could operate in his current assignment with no restrictions. He wore glasses for reading only. His most recent hearing test was on May 18, 1998; no operating restrictions were noted. The conductor indicated that he had not taken any medications before the accident.

The Metrolink 809 engineer's last company physical was on June 14, 2001. No operating restrictions were indicated.

The Metrolink 809 conductor's last physical examination was conducted on November 1, 1999. No operating restrictions were indicated.

Pursuant to Federal Railroad Administration (FRA) postaccident toxicological test requirements as found at 49 *Code of Federal Regulations* (CFR) 219 Subpart C, each crewmember on the BNSF and Metrolink trains involved in the accident provided specimens that were tested for the presence of alcohol and drugs.[29] All of the crewmembers on both trains tested negative for all tested substances.

Tests and Research

Signal System

On April 23, 2002, investigators from the BNSF, Metrolink, Amtrak, the FRA, the Brotherhood of Railroad Signalmen, the California Public Utilities Commission, and the Safety Board began a field inspection of the railroad signal system. The postaccident inspection found all signal units, switches, and the signal cases at the intermediate signals and at CP Atwood locked and secured with no indications of tampering or vandalism.

All relay positions were found to be in accordance with the physical location of the accident trains and with the displayed signal aspects. Ground tests were performed, signal searchlight mechanisms were inspected, and lamp operating voltages were verified. Movements of the spectacle arm[30] were smooth with no binding. All mechanisms were found to be operating properly with no exceptions noted. Track connections and insulated joints were inspected, and no exceptions were noted. Information developed from signal system data loggers and dispatch center records during the investigation indicated that this signal at MP 42.31 was displaying *approach* at the time BNSF 5340 passed the signal.

[29] Specimens were tested for cannabinoids, cocaine, opiates, amphetamines, methamphetamines, phencyclidine, barbiturates, and benzodiazapines.

[30] A *spectacle arm* holds different color lenses that it positions in front of a single lamp to display the proper signal color.

Sight-Distance Tests

On April 25, 2002, Safety Board investigators conducted sight-distance tests by riding a locomotive of similar design to BNSF 5340 over the route the freight train traversed before striking the Metrolink train and observing the distances at which signal aspects could be seen and identified. The time of day and weather were similar to those on the day of the accident. Three trips were made, each starting at Fullerton and ending near the collision point. Investigators noted and recorded the visibility of the wayside signals at MP 44.03 (which showed *clear* when BNSF 5340 passed), MP 42.31 (which showed *approach*), and MP 40.71 (which showed *stop*). The distances recorded for the three runs were used to develop an average sight distance for each signal.

On the first run, the signals were set (from west to east) at *clear*, *approach*, and *stop*, which duplicated their aspects during the passage of BNSF 5340. On the second run, all signals were set at *clear*. On the third run, signals were again set at *clear*, *approach*, and *stop*.

The signal with the shortest average sight distance was the first one, at MP 44.03, which could be identified at about 1,960 feet. The next signal, at MP 42.31, could be seen and identified at approximately 3,010 feet. This was the signal that, on the day of the accident, was showing *approach* but that was called out as *clear* by the conductor. According to the locomotive event recorder, the accident train went by this location at 42 to 43 mph. With 3,010 feet of visibility and with the train moving at 42 mph, the signal would have been visible for about 48 seconds. The last signal before the collision point, signal 4EA at MP 40.71, could be seen and identified at an average distance of about 2,375 feet. Because of its weight and speed, train BNSF 5340 could not stop short of the signal.

Placentia Police Department records indicate that shortly after the accident, the BNSF 5340 engineer told an officer that he could not see the *approach* signal, that the sun was very bright behind the signal, and that he could not distinguish the color. When the engineer was interviewed by Safety Board investigators on April 24, he said that he did not "catch" the signal but that the conductor told him it was *clear*.

Locomotive Event Recorder Data

Event recorder data were recovered from Metrolink locomotive unit 859, Metrolink cab car 634, and the three BNSF locomotive units. The data were reviewed by Safety Board staff. The data from the various recorders on each train were found to be in reasonable correlation. Metrolink cab car 634 (the lead car on Metrolink 809) experienced significant damage in the collision. The recorder installed on that car was removed and re-installed on cab car 636 in order to retrieve the data. The data from the Metrolink cab car 634 event recorder show that the train was placed into emergency braking, coming to a full stop at recorder time[31] 08:06:27 and was standing when it was struck by BNSF 5340.

[31] Each event recorder records time independently from an internal clock. Typically, these clocks vary somewhat from actual time and from one other.

The data from the recorder on BNSF 5340 (the lead locomotive on the freight train) show locomotive engineer activity, including a throttle movement and dozens of whistle activations as the train approached and traversed grade crossings in the 10 minutes before the accident. The data indicate that at recorder time 08:15:12 and at a train speed of 49 mph, an emergency brake application was initiated by the engineer. Between recorder time 08:15:13 and 08:16:00, train speed decreased from 49 to 0 mph. At recorder time 08:15:45, train speed was 23 mph. One second later, at 08:15:46, the train's speed dropped to 17 mph. The recorder data indicate that the distance to a stop traveled by BNSF 5430 from the point where the speed rapidly decreased from 23 to 17 mph was 233 feet.

Other Information

Use of Cellular Telephones by BNSF 5340 Crew

The BNSF 5340 conductor told Safety Board investigators that both he and the engineer had used their cellular telephones during the accident trip. The conductor stated that soon after they departed the yard, he had a brief conversation with his wife, after which the engineer made a personal call using his own cell phone. According to the conductor, the last conversation ended before the train reached Fullerton. The conductor said he was not aware of any BNSF rule prohibiting the use of a cellphone while operating a train.

The BNSF 5340 engineer told investigators that he called his wife sometime before reaching Fullerton and that he did not use his cell phone again until after the collision, when he used it to contact BNSF officials. A review of cell telephone records for both the conductor's and engineer's numbers confirmed these accounts.

Federal regulations do not prohibit a locomotive engineer from using a cell phone while at the controls of a moving train. Since April 10, 1994, the *General Code of Operating Rules* (which BNSF has followed since about 1985) has had the following rule (Rule 1.10, "Games, Reading, or Electronic Devices") about the use of equipment not related to train operations:

> Unless permitted by the railroad, employees on duty must not: Play games, read magazines, newspapers, or other literature not related to their duties or use electronic devices not related to their duties.

Additional guidance on cell phone use is provided by the BNSF published Safety Briefing on September 20, 2001 (SB-2001-04):

> Under no circumstances should a train crew on the head-end involve themselves in personal cell phone conversations while the train is moving. Inbound callers will understand that the employee will call back when the opportunity presents itself (usually while stopped in a siding - - and NOT while inspecting a passing train.) Refer to GCOR 1.10, which covers restriction in the use of non-authorized electronic devices not related to railroad duties.

In its investigation of a May 28, 2002, collision between two BNSF freight trains in Clarendon, Texas,[32] the Safety Board found that use of a cell phone by the engineer of one of the trains may have distracted him to the extent that he was unaware of the dispatcher's instructions that he stop his train at a designated point. As a result of that accident, the Board. on June 13, 2003, recommended that the FRA:

R-03-1

Promulgate new or amended regulations that will control the use of cellular telephones and similar wireless communication devices by railroad operating employees while on duty so that such use does not affect operational safety.

After the Placentia and Clarendon accidents and as a result of a collision on a different BNSF subdivision,[33] the BNSF, on June 18, 2002, issued instructions to operating employees that specifically prohibited the use of cell phones and laptop computers while on duty, with certain exceptions. Per these instructions, locomotive engineers "are prohibited from using cell phones/laptop computers while operating the controls of a locomotive."

BNSF Program of Operational Tests

Under regulations at 49 CFR Part 217, the BNSF is required to periodically conduct operational tests and inspections[34] to determine the extent of operating employee compliance with the code of operating rules, timetables, and timetables special instructions.

To comply with the regulations, the BNSF program must:

- Provide for operational testing and inspection under the various operating conditions on the railroad;
- Describe each type of operational test and inspection adopted, including the means and procedures used to carry it out;
- State the purpose of each type of operational test and inspection;
- State, according to operating divisions where applicable, the frequency with which each type of operational test and inspection is conducted; and
- Provide for a record-keeping system meeting the requirements of the regulation.

[32] National Transportation Safety Board, *Collision of Two Burlington Northern Santa Fe Freight Trains Near Clarendon, Texas, May 28, 2002*. Railroad Accident Report NTSB/RAR-03/01 (Washington, D.C.: NTSB, 2003).

[33] This collision was not investigated by the Safety Board.

[34] Typically referred to as "efficiency tests."

The BNSF provided the Safety Board with a copy of its program, entitled *Operations Testing Reference Guide*.[35] At the time of the accident, the FRA had not taken any exceptions to the program submitted by the BNSF. After the accident, the Consumer Protection and Safety Division of the California Public Utilities Commission issued an investigation report concerning the Placentia collision. One portion covered the postaccident inspections performed by the commission and the FRA. Following is an excerpt from that report:

> …audit results indicated that BNSF managers were not conducting quality operational efficiency tests.[[36]] As a result, [California Public Utilities Commission] inspectors[[37]] filed 10 federal operating practice violations against the BNSF as well as 85 Railroad Operating Rule (ROR) defects (CFR Part § 217.9).

FRA representatives confirmed that these alleged violations were filed as five separate cases. Two of the cases involve alleged falsification of efficiency tests. As of this writing, one of the two cases has been dropped because of insufficient evidence, and the second case is expected to be dropped or settled by the end of FY '04. The other three cases, which did not involve allegations of falsification, were settled with the railroad at the end of FY '03.

Postaccident Actions–BNSF

After the Placentia accident, the BNSF revised its *Operations Testing Reference Guide*, adding a specific test entitled "Block Signal–Approach Aspects." The test involves confirming that crews reduce train speed and handle trains appropriately when an *approach* signal is encountered.

Also since the Placentia accident, the BNSF has developed a pilot program of signal rules compliance testing that is conducted remotely from the dispatching center. When remote testing is conducted, the dispatcher sets up a *stop* signal for a train. The train crew's actions in response to the signal are captured by the locomotive event recorder. Through the use of wayside radio communication links, this event recorder data can then be downloaded remotely and evaluated for compliance by company officials. This system allows crew compliance with *approach* and *stop* signal indications to be evaluated on an almost real-time basis.

The pilot program also involves querying historical computerized dispatching records to identify locations, such as CP Atwood, where trains have encountered stop signals infrequently. Those locations can then be highlighted for testing, either through local "on-the-ground" testing operations or through remote testing from the dispatch center.

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[35] Last update: April 8, 2002.

[36] *Efficiency tests* involve setting up a scenario, such as a restrictive signal, and documenting the operating crew's actions to verify that they comply with applicable rules.

[37] The California Public Utilities Commission employs inspectors certified by the FRA to conduct oversight as part of a State participation program.

Postaccident Actions–Metrolink

Emergency Window Exterior Signage. After the on-scene investigation, Metrolink installed exterior instructional signage at the intermediate-level emergency windows on its delivery series 200 and 207 railcars. With this application, intermediate-level exterior window removal signage is in place on the entire railcar fleet.

Emergency Window Grommet Design. Metrolink management informed Safety Board investigators that they are currently testing an intermediate deck-level emergency exit window grommet design that will allow the emergency exit/access windows to be removed without having to break the window. This grommet design uses removable "zip" or "filler" strips on both the interior and exterior at the four intermediate deck-level emergency windows. If the window grommet testing is successful, the new window grommet type will be installed on the emergency access windows of the 200 and 207 delivery series railcars of the Metrolink fleet. This would result in all of the emergency access windows in the Metrolink railcar fleet being removable from the railcar without the need to break the window glazing.

Mass Casualty Training Drill Exercise Coincident to Accident

On the morning of the accident, the Brea Fire Department[38] was hosting a scheduled mass casualty training drill exercise[39] to begin at 9:15 a.m. The Orange County Fire Authority and local fire and police agencies were to participate as mutual aid in this exercise, which was conducted in conjunction with the Orange County Hospital System annual accreditation drill. The training drill was in the final stages of preparation at the time of the accident and was to involve a request for 30 ambulances and almost 100 personal trauma transports (to 16 local hospitals). Upon learning of the actual train collision, officials suspended the training drill and immediately directed the emergency services resources to the Placentia accident. Local hospitals, as well as the local chapter of the American Red Cross (the hospitals and the Red Cross were participating in the drill), were also notified of the train collision and diverted their resources accordingly.

Regulatory Framework

Various aspects of BNSF and Metrolink operations fall under the regulatory authority of the FRA as outlined in CFR 49 Parts 200-299. California Public Utilities Commission personnel enforce FRA regulations in a State participation program outlined under CFR 49 Part 212.

The FRA has contracted with the Volpe National Transportation Systems Center[40] to perform research on passenger railcar crashworthiness. According to a Volpe Center representative, the research includes field studies of actual collision damage, and a contractor to the Volpe Center has gathered data on the Placentia accident. Also, the Volpe

[38] Brea is a neighboring municipality to the northwest of Placentia.

[39] The activity was organized by the Orange County Fire Operations Chiefs (a subgroup of the Orange County Fire Chief's Association).

[40] The Volpe Center is a Federal fee-for-service organization within the Department of Transportation.

Center is currently performing finite element computer simulation modeling of carbody structural deformation and of occupant kinematics (as occurred in the Placentia collision) in order to identify an improved table design, possibly by incorporating exposed edge cushioning and a provision for no detachment from the wall. Volpe Center staff also anticipate conducting, in December 2003, a full-scale two-car passenger railcar crash test using crash test dummies and seats with a table similar to those that were in place in the Placentia accident.

BNSF Train Collision Avoidance System Testing

The BNSF is testing a global positioning system-based radio telemetry collision avoidance system. The system, designated ETMS for "electronic train management system," involves a track system database, global positioning system units on locomotives, and train-to-wayside communications. A locomotive cab display tells the engineer the current authorized speed, the next signal aspect, upcoming speed restrictions, the distance to the next signal, and other information related to safety of operations. Allowable and actual speed are displayed; and as the train approaches a speed restriction, restricting signal, or misaligned switch, allowable speed decreases along a safe braking profile based on train tonnage and braking capability. The engineer must stay at or under the allowable speed or a warning sounds, followed by an automatic brake application that brings the train to a stop. Such stops are annunciated to the dispatcher as well.

A beta test of the system was successful, and the BNSF plans a pilot installation on 135 miles of track between Beardstown and Centralia, Illinois, in 2004. The location was chosen because it offers a mix of operating conditions. About 50 locomotives will be equipped with the system and will be kept captive between the two points.

If pilot tests are successful, some potential issues for future full implementation of such a system include cost (the BNSF has more than 4,000 locomotives and 33,500 route miles of track), mixing non-equipped foreign locomotives (Amtrak, Metrolink, etc.) on BNSF track, and interoperability with other railroads that use other communications technology. Testing of the BNSF system is partially funded by the FRA's Office of Railroad Development.

Analysis

General

The accident occurred during daylight hours and in clear weather. Inspection records and testing of the signal and train braking systems revealed no defects that would explain the failure of the BNSF 5340 crew to slow their train and stop short of signal 4EA at CP Atwood, which was displaying *stop*. Postaccident sight-distance tests revealed that the *approach* signal in advance of signal 4EA was clearly visible from more than 3,000 feet away. Federally mandated drug and alcohol test results were negative for all crewmembers involved in the accident.

The Safety Board considered whether the BNSF crew's performance was affected by fatigue. The engineer told Safety Board investigators he felt "pretty good" when his train departed Hobart Yard. Similarly, the conductor, who acknowledged that he felt tired when he reported for duty, said that he was "wide awake" after taking a 1 1/2 hour nap while waiting for clearance to depart Hobart Yard. During the early part of the accident trip, the crewmembers were conversing, which would have contributed to their being alert and awake. Data from locomotive event recorders also showed that as the train approached the misidentified signal, the engineer's control inputs were appropriate and timely. Finally, the accident occurred at 8:16 a.m., a time when the average person has passed the period of circadian[41] low and is typically experiencing a heightened level of alertness.

The Safety Board therefore concludes that there was no evidence of fatigue impairment or alcohol or drug use in this accident, and the following factors were neither causal nor contributory to the accident: weather, signal visibility, and signal or train braking system malfunction.

Accident Discussion

At the time of the accident, that portion of the BNSF signal system governing eastbound trains, such as BNSF 5340, on track No. 2 approaching CP Atwood involved three signals. All three signals were capable of displaying *clear*, *approach*, or *stop*, and the signals changed automatically, depending on train traffic in the vicinity of the control point.

[41] *Circadian rhythms* describe the regular recurrence, in cycles of about 24 hours, of biological processes or activities such as sensitivity to drugs and stimuli, hormone secretion, sleeping, and eating. Performance degradation is most likely to occur during the natural circadian low points that occur for most people between 2:00 a.m. and 6:00 a.m.

At the time of the accident, the signal governing eastbound movement at CP Atwood, signal 4EA at MP 40.71, was showing *stop* because of the presence of Metrolink 809. Information developed from signal system data loggers and dispatch center records during the investigation indicated that the signal in advance of signal 4EA, the signal at MP 42.31, was displaying *approach* and that the next signal to the west of this signal, at MP 44.03, was displaying *clear*. As BNSF 5340 proceeded toward CP Atwood, the first signal it encountered was the *clear* signal at MP 44.03. This signal required no special action on the part of the crew, and the train continued at track speed. The next signal was the *approach* signal at MP 42.31. Encountering this signal, the crew of BNSF 5340 should have slowed their train's speed to 30 mph or less and been prepared to stop at the next signal.

But when train BNSF 5340 approached the *approach* signal at MP 42.31, the crewmembers were engaged in a conversation, and the engineer said he was not watching the signal. The conductor called the signal, incorrectly, as *clear*. Although the engineer told BNSF investigators that he "confirmed" the conductor's call out of the signal as "clear," he indicated to Safety Board investigators that he did not, as required by BNSF operating rules, personally observe the signal and identify its aspect. He stated that when he did look toward the signal, his train had already passed it. In this case, the engineer took the word of the conductor that the signal was *clear* and continued to operate the train accordingly. The Safety Board therefore concludes that the BNSF 5340 train crew were insufficiently attentive to the operation of their train, with the result that they failed to see, identify, and respond appropriately to the *approach* signal indication at MP 42.31. By the time the engineer and conductor saw that the next signal, signal 4EA, was displaying *stop* and the engineer placed the train brakes in emergency, the train was traveling too fast (about 49 mph) to be brought to a stop before striking Metrolink 809. Ample distance existed between the *approach* and *stop* signals to allow the train to slow sufficiently to stop short of the *stop* signal and avoid the collision if the engineer had begun braking as required. The Safety Board therefore concludes that had the BNSF 5340 crew operated their train in accordance with the signal indications, the accident would not have occurred.

Crew Alertness to Signals

Inattention

The *General Code of Operating Rules* required both crewmembers to remain alert for the signal, to call out the signal, and to continue observing the signal until the train passed. Investigators found that the *approach* signal was visible from more than 3,000 feet away, or for 48 seconds given the speed of BNSF 5340 at that time. As evidenced from their statements to investigators, the BNSF 5340 crewmembers were focusing attention on their conversation rather than on the signals governing the operation of their train.

Signal Recording

Besides calling signals, one of the mechanisms the BNSF uses to encourage heightened crew alertness to signal indications is the signal awareness form. BNSF procedures require that conductors enter the time and train speed whenever a restrictive (less-than-*clear*) signal is encountered. A *clear* signal requires only that a check mark be made in a column on the form, and the procedures do not clearly specify that the entry must be made at the time the *clear* signal is observed. The BNSF 5340 conductor told Safety Board investigators that he routinely did not enter *clear* signals on the form when he observed them. Rather, he would wait until he encountered a restrictive signal and would then backfill the form in the *clear* column. This meant that the conductor did not need to take any action other than calling out the signal when *clear* signals were encountered.

For efficiency, trains are generally operated such that the majority of signals encountered by an operating crew will be *clear*. Thus, conductors may inadvertently become passive in their observance of signals. In that case, the additional effort required by conductors to complete the signal awareness form when the signal displays either *stop* or *approach* (that is, the additional requirement to record the speed and time the signal was passed, as well as the aspect name) may prompt the crew to be more actively involved in observing the signals.

In the view of the Safety Board, if conductors were also required to record speed and time information for *clear* signals, they would, of necessity, take a more active role in observing *all* signals. In this accident, for example, the BNSF 5340 conductor stated that he made an effort to observe the misidentified *approach* signal only when the train was close to the signal. That action was limited to making a single observation and calling out "clear" for the engineer to confirm. If the conductor had been required to complete the signal awareness form for a *clear* signal in a similar manner to other signals, he may have felt compelled to observe all signals earlier (even those expected to be *clear*) in order to have more time to accurately observe and record the signal-related information. This earlier observation of signals would also provide conductors with additional time to make repeated signal observations if necessary. At the same time, the added requirement would not in any way interfere with the conductor's other duties.

The Safety Board therefore concludes that had the BNSF 5340 conductor been more actively involved by entering *clear* signals on his signal awareness form at the time he observed them, his awareness of signal indications may have been increased, and he may not have misidentified an *approach* signal as *clear*.

The BNSF conductor's practice of not entering *clear* signals on his signal awareness form at the time he observed them was not specifically prohibited by BNSF rules, as those rules required different actions for *clear* signals than for more restrictive signals. The Safety Board therefore believes that the BNSF should revise its signal awareness form procedure to require recording of time, speed, and aspect name for all signals encountered at the time they are encountered.

Enforcement of Operating Rules

FRA regulations in 49 CFR 217.9 specifically address a program of operational tests, inspections, and record-keeping on railroads subject to FRA jurisdiction. Such rules compliance programs typically include check rides, efficiency tests, and event recorder reviews to confirm that engineers are following the rules.

After the accident, the BNSF revised its program, adding an *approach* signal test. Additionally, the BNSF reviewed dispatching and testing records on its system to identify locations, such as CP Atwood, where stopping trains was uncommon. Local railroad officials are now advised of these locations, and additional testing is conducted. The BNSF has also developed a remote testing program that allows *stop* signal testing to be conducted from the dispatch center. This is particularly useful for remote field locations, where access for testing by local railroad officials is difficult.

While rules compliance enforcement programs can be effective accident prevention tools, such programs cannot be completely relied upon to eliminate human-error accidents. This is one of the reasons that the Safety Board has long recommended the installation of redundant systems to automatically take action and stop a train when a crew does not comply with signal indications.

Survival Factors

Workstation Tables and Injuries

The workstation tables fitted to Metrolink bi-level railcars are rigid, unyielding structures that are attached to the railcar sidewall, thus affording little impact energy attenuation upon being struck by a train occupant. The initial collision speed was about 23 mph, and the distance the Metrolink train was shoved back was about 243 feet. There is minimal crush attenuation provided to the cab car, and no crush attenuation provided to the freight locomotive. The two individuals who sustained fatal injuries in this accident were seated at a workstation table in the lead Metrolink bi-level railcar, facing the direction of travel. The pathology reports of those two individuals indicated that both received severe blunt impact trauma injuries to the chest and upper abdomen.

The deceleration forces of the accident would have been expected to thrust those forward-facing persons seated at workstation tables directly toward the exposed edge of the workstation table. The degree and types of injuries sustained by the forward-facing railcar occupants seated at several of the workstation tables in this accident are consistent with such a mechanism of injury. Therefore, the Safety Board concludes that the two fatal injuries and many of the serious abdominal injuries to passengers throughout the Metrolink train likely resulted from impact with the workstation table edges.

Similar workstation tables have been installed in the entire Bombardier bi-level railcar fleet consisting of about 700 cars now in North American service. Bombardier did not conduct any biomechanical injury causation assessment in the design and installation of these workstation tables. Further, there are no FRA standards that specifically address provisions for workstation tables in passenger railcars.

The identification of crash injury causation hazards of workstation tables is accomplished only through a detailed biomechanical assessment using finite element simulation modeling or physical testing. The Volpe Center is currently performing finite element computer simulation modeling of carbody structural deformation and of occupant kinematics in order to identify an improved table design. The Safety Board has also been informed that the Volpe Center, in conjunction with the FRA, plans to conduct a full-scale two-car passenger railcar crash test in December 2003. The test will involve the use of crash test dummies and seats with tables similar to those that were in place in the Placentia accident. Data obtained from this test could form the basis for new standards or regulations regarding workstation tables in passenger railcars.

Emergency Access to Car End Areas Through Designated Emergency Windows.

Exterior instructional signage for first responders was not present at the intermediate-level deck emergency access windows in the Metrolink delivery series 200-207 railcars. Impact forces in this accident resulted in blockage of the stairway and the end bulkhead door of Metrolink cab car 634, essentially isolating passengers in one end of the car. Fortunately, the passengers were not incapacitated, and they were able to remove these emergency windows that, at the time of the accident, had instructional signage and pull rings on the inside (but not on the outside) of the windows. Removal of the windows from the outside would have been more difficult than from the inside. While well-equipped and trained emergency responders may be able to break or remove emergency exit windows to gain access to incapacitated passengers inside, the first people on the scene of railroad accidents are often nearby residents or passersby. Emergency access instructions on all emergency windows could aid such “good Samaritans” in providing assistance. The Safety Board concludes that the absence of exterior instructional signage on emergency exit windows of the Metrolink cars could hinder emergency response in future accidents, particularly in a scenario in which first responders might be untrained and ill-equipped civilian “good Samaritans.”

FRA regulations do not specifically require exterior instructional signage for emergency responders on exterior intermediate-level deck emergency windows. Regulatory requirements for emergency window exits in passenger railcars are under 49 CFR 238.113, which states “If the passenger car has multiple levels, each main level shall have a minimum of four emergency window exits, ….” Regulatory requirements under 49 CFR 223.9(d)(1), and 49 CFR 223.9(d)(2), respectively, require that instructional signage describing emergency removal procedures be provided at the emergency window locations on both the inside and the outside of the railcar. Metrolink representatives told investigators that the intermediate level of the railcars is not considered a “main” level; hence, the exterior emergency windows at that level of the railcars were not required to have instructional signage.

Since the accident, Metrolink has taken steps to install such instructional signage on this series of railcar (a later delivery series had such signage installed) and is testing an emergency window design that will allow responders to remove intermediate-level windows from the outside without breaking them.

The Safety Board is encouraged that Metrolink is taking prompt action to improve emergency access to its railcars but is concerned that passengers and crew riding on other railroads in the intermediate level of this type of railcar,[42] may not be afforded the same degree of emergency access protection that is afforded to persons riding in the main level of that same railcar. The Safety Board therefore believes that the FRA should revise the language of 49 CFR 238.113(a)(1) to reflect that appropriate exterior instructional signage describing the emergency removal procedure be required at emergency windows on all levels of a multiple-level passenger railcar.

Emergency Response

The initial notification to local emergency response resources occurred within 1 minute, and personnel were dispatched and en route almost immediately. Arrival of responders on scene occurred within about 3 minutes of dispatch. A mass casualty incident command system was established, and additional mutual aid resources were diverted to the scene from a scheduled training drill as support. Records indicate that all immediate transport priority injured persons were extricated, triaged, stabilized, and transported from the scene within about 1 hour of the initial response. All remaining injured were transported from the scene within about 2 hours. The Safety Board therefore concludes that the emergency response to this incident was timely, effective, and appropriate to the incident.

Positive Train Control

The Safety Board is concerned about the safety of railroad operations when backup systems are not available to intervene if a train crew operates a train improperly or fails to comply with wayside signals. Safety Board railroad accident investigations over the past 30 years have shown conclusively that the most effective way to avoid train-to-train collisions is through the use of positive train control systems that will automatically assume some control of a train when the train crew does not comply with the requirements of a signal indication. In fact, positive train control has been on the Safety Board's list of "Most Wanted" transportation safety improvements since the list was developed in 1990.[43]

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[42] Approximately 300 railcars.

[43] The Safety Board developed the "Most Wanted" list, drawn up from previously issued safety recommendations, to bring special emphasis to the safety issues the Board deems most critical. The Most Wanted list is reviewed, revised, and reissued as needed, or at least annually.

Most recently, in its investigation of the previously referenced May 28, 2002, collision of two BNSF freight trains near Clarendon, Texas, the Safety Board determined that the accident would have been prevented if an operational positive train control system had been in place on that section of track. Similarly, had such a system been in place and operational on the territory where the Placentia accident occurred, it would have intervened when the engineer failed to slow his train in response to the *approach* signal and would have stopped the train short of the *stop* signal. The Safety Board concludes that had a fully implemented positive train control system been in place on the BNSF San Bernardino Subdivision at the time of the accident, the system would have intervened to stop the freight train before it could enter the track area occupied by Metrolink 809, and the collision would not have occurred.

Since 1969, the Safety Board has issued a number of safety recommendations related to positive train control. The most recent safety recommendation was issued as a result of the Safety Board's investigation of a train collision involving three freight trains in Bryan, Ohio.[44] That recommendation, issued to the FRA, was as follows:

> <u>R-01-6</u>
>
> Facilitate actions necessary for development and implementation of positive train control systems that include collision avoidance, and require implementation of positive train control systems on main line tracks, establishing priority requirements for high-risk corridors such as those where commuter and intercity passenger railroads operate.

In a response to the Safety Board's request for an update on the status of this recommendation, which is currently classified "Open–Acceptable Response," the FRA administrator, in a May 5, 2003, letter to the Safety Board, stated:

> FRA is doing everything within its power to prepare the way for PTC [positive train control] and encourage its rapid deployment. FRA shares the Board's disappointment that certain aspects of this work have not proceeded as rapidly as projected. For instance, the Association of American Railroads has yet to provide standards for interoperability of PTC systems. Nevertheless, we remain convinced that the momentum achieved to date, together with the strong potential for PTC technology to support other business needs, will result in the safety advances that we both seek.

In the letter, the FRA stated that it was "moving forward across a broad front to create the conditions under which [positive train control] systems can be more widely deployed on the national rail system." The FRA provided the following examples of its support for the demonstration and deployment of candidate positive train control technologies:

> On the Northeast Corridor (NEC), FRA has issued an order requiring installation

[44] National Transportation Safety Board, *Collision Involving Three Consolidated Rail Corporation Freight Trains Operating in Fog at Bryan, Ohio, January 17, 1999*, Railroad Accident Report NTSB/RAR-01/01 (Washington, D.C.: NTSB, 2001).

> and use of the Advanced Civil Speed Enforcement System (ACSES) where Amtrak has sought to increase speeds in order to reduce trip times. ACSES, working in concert with existing Automatic Train Control system[s], provides PTC core functions. New Jersey Transit has responded by developing a similar, interoperable system it is presently deploying. These new train control systems are now in service and are being rolled out progressively to larger territories within the NEC. Amtrak's ownership and dispatching role over much of the corridor has made this process feasible.
>
> On Amtrak's Michigan line, FRA has joined with Amtrak and the State of Michigan to develop and install the Incremental Train Control System (ITCS), which currently supports train speeds to 90 mph.
>
> Working with the State of Illinois, the Union Pacific Railroad, Amtrak, and the Association of American Railroads, FRA is a funding partner in the North American Joint PTC program. FRA's Office of Safety is presently reviewing the first of the final safety documents constituting the Product Safety Plan for this system—in effect, making the first use of the proposed regulatory structure described above even before a final rule is issued. This system is the most technically ambitious of the PTC projects to date and will play a key role in convincing a skeptical railroad industry that a central-office PTC architecture can succeed by meeting the dual tests of safety and availability (reliability)….
>
> FRA is working with the CSX [Railroad], Burlington Northern Santa Fe Railway, and the Alaska Railroad on additional 'overlay' systems that show potential for significant safety gains at reduced cost. According to the railroads, each intends to pursue the possibility of broad application of the technology. FRA's role is to provide needed regulatory relief, technical assistance, and encouragement, as well as to raise appropriate safety issues—particularly with respect to human factors. FRA has also provided funding towards both the BNSF and the Alaska Railroad projects.

While the Safety Board understands that positive train control development is complex and expensive, the Board remains convinced that these systems provide the best approach to reduce human-error collisions. While the Safety Board is aware of the BNSF program to develop a train collision avoidance system, the Safety Board remains concerned that it has taken so long for the FRA to require and for the railroad industry to develop and implement such systems. Therefore, the Safety Board reiterates Safety Recommendation R-01-6 to the FRA.

As noted in the FRA letter, one of the issues hindering development and deployment of positive train control systems is the lack of standards for interoperability. Such standards are necessary to ensure that the effectiveness of positive train control systems is not compromised by the sharing of locomotive units that is common among railroads. The Association of American Railroads is working with railroad industry representatives to formulate the interoperability standards, but progress thus far has been slow. The Safety Board is vitally interested in this issue and therefore believes that the Association of American Railroads should report to the Safety Board the milestones and activities needed for completion of the interoperability standards for positive train control systems and its priorities for completion of this effort.

Conclusions

Findings

1. There was no evidence of fatigue impairment or alcohol or drug use in this accident, and the following factors were neither causal nor contributory to the accident: weather, signal visibility, and signal or train braking system malfunction.

2. The BNSF 5340 train crew were insufficiently attentive to the operation of their train, with the result that they failed to see, identify, and respond appropriately to the *approach* signal indication at MP 42.31.

3. Had the BNSF 5340 crew operated their train in accordance with the signal indications, the accident would not have occurred.

4. Had a fully implemented positive train control system been in place on the Burlington Northern Santa Fe's San Bernardino Subdivision at the time of the accident, the system would have intervened to stop the freight train before it could enter into the track area occupied by Metrolink 809, and the collision would not have occurred.

5. Had the BNSF 5340 conductor been more actively involved by entering *clear* signals on his signal awareness form at the time he observed them, his awareness of signal indications may have been increased, and he may not have misidentified an *approach* signal as *clear*.

6. The two fatal injuries and many of the serious abdominal injuries to passengers throughout the Metrolink train likely resulted from impact with the workstation table edges.

7. The absence of exterior instructional signage on emergency exit windows of the Metrolink cars could hinder emergency response in future accidents, particularly in a scenario in which first responders might be untrained and ill-equipped civilian "good Samaritans."

8. The emergency response to this incident was timely, effective, and appropriate to the incident.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the April 23, 2002, collision of a Burlington Northern Santa Fe freight train and a Metrolink commuter train in Placentia, California, was the freight train crew's inattentiveness to the signal system and their failure to observe, recognize, and act on the *approach* signal at milepost 42.31. Contributing to the accident was the absence of a positive train control system that would have automatically stopped the freight train short of the *stop* signal and thus prevented the collision.

Recommendations

As a result of its investigation of the April 23, 2002, collision of a Burlington Northern Santa Fe freight train and a Metrolink commuter train in Placentia, California, the National Transportation Safety Board makes the following safety recommendations:

New Recommendations

To the Federal Railroad Administration:

Revise the language of 49 *Code of Federal Regulations* 238.113(a)(1) to reflect that appropriate exterior instructional signage describing the emergency removal procedure be required at emergency windows on all levels of a multiple-level passenger railcar. (R-03-21)

To the Burlington Northern Santa Fe Railway Company:

Revise your signal awareness form procedure to require recording of time, speed, and aspect name for all signals encountered at the time they are encountered. (R-03-22)

To the Association of American Railroads:

Report to the National Transportation Safety Board the milestones and activities needed for completion of the interoperability standards for positive train control systems and your priorities for completion of this effort. (R-03-23)

Recommendation Reiterated in This Report

The National Transportation Safety Board reiterates the following safety recommendation to the Federal Railroad Administration:

R-01-6

Facilitate actions necessary for development and implementation of positive train control systems that include collision avoidance, and require implementation of positive train control systems on main line tracks, establishing priority requirements for high-risk corridors such as those where commuter and intercity passenger railroads operate.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

Ellen G. Engleman
Chairman

Mark V. Rosenker
Vice Chairman

John J. Goglia
Member

Carol J. Carmody
Member

Richard F. Healing
Member

Adopted: October 7, 2003

Appendix A

Investigation

The National Transportation Safety Board was notified of the Placentia, California, accident about 11:39 a.m., eastern standard time, on April 23, 2002, and dispatched a major railroad accident investigation team to the accident scene. Investigative groups examined the operation, track, signals, communications, mechanical, survival factors, human performance, and event recorder aspects of the accident. Then-Chairman Marion Blakey was on the scene during the on-site investigation.

Parties to the investigation were the Federal Railroad Administration, the California Public Utilities Commission, Amtrak, Bombardier Transportation Company, the Burlington Northern Santa Fe Railway, Metrolink, the Brotherhood of Locomotive Engineers, the Brotherhood of Railroad Signalmen, the United Transportation Union, Orange County Fire Authority, and the Placentia Police Department.

No public hearings or depositions were held in connection with this accident.

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