Derailment of Amtrak Auto Train P052-18 on the CSXT Railroad Near Crescent City, Florida
April 18, 2002

Railroad Accident Report

NTSB/RAR-03/02

PB2003-916302
Notation 7487A

National Transportation Safety Board
Washington, D.C.

this page intentionally left blank

Railroad Accident Report

Derailment of Amtrak Auto Train P052-18 on the CSXT Railroad Near Crescent City, Florida
April 18, 2002

NTSB/RAR-03/02
PB2003-916302
Notation 7487A
Adopted August 5, 2003

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

National Transportation Safety Board. 2003. *Derailment of Amtrak Auto Train P052-18 on the CSXT Railroad Near Crescent City, Florida, April 18, 2002.* Railroad Accident Report NTSB/RAR-03/02. Washington, DC.

Abstract: About 5:08 p.m. eastern daylight time on April 18, 2002, northbound National Railroad Passenger Corporation (Amtrak) train P052-18, the Auto Train, derailed 21 of 40 cars on CSX Transportation track near Crescent City, Florida. The train derailed in a left-hand curve while traveling about 56 mph. The train was carrying 413 passengers and 33 Amtrak employees. The derailment resulted in 4 fatalities, 36 serious injuries, and 106 minor injuries. The equipment and track costs associated with the accident totaled about $8.3 million.

As a result of its investigation of this accident, the Safety Board identified the following safety issues: continuous welded rail temperature control; continuous welded rail restraint, including ballast and rail anchors; continuous welded rail maintenance procedures and standards; means of end-of-train device activation; Amtrak passenger accountability procedures; and securement of folding armchairs on Amtrak Superliner sleeper cars.

As a result of its investigation of this accident, the National Transportation Safety Board makes safety recommendations to CSX Transportation, Inc., Amtrak, the Federal Railroad Administration, and the Transportation Security Administration.

Recent publications are available in their entirety on the Web at <http://www.ntsb.gov>. Other information about available publications also may be obtained from the Web site or by contacting:

National Transportation Safety Board
Public Inquiries Section, RE-51
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594
(800) 877-6799 or (202) 314-6551

Safety Board publications may be purchased, by individual copy or by subscription, from the National Technical Information Service. To purchase this publication, order report number **PB2003-916302** from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161
(800) 553-6847 or (703) 605-6000

Contents

Appendixes

Executive Summary

About 5:08 p.m. eastern daylight time on April 18, 2002, northbound National Railroad Passenger Corporation (Amtrak) train P052-18, the Auto Train, derailed 21 of 40 cars on CSX Transportation (CSXT) track near Crescent City, Florida. The train derailed in a left-hand curve while traveling about 56 mph. The train was carrying 413 passengers and 33 Amtrak employees. The derailment resulted in 4 fatalities, 36 serious injuries, and 106 minor injuries. The equipment and track costs associated with the accident totaled about $8.3 million.

The National Transportation Safety Board determines that the probable cause of the April 18, 2002, derailment of Amtrak Auto Train P052-18 near Crescent City, Florida, was a heat-induced track buckle that developed because of inadequate CSX Transportation track-surfacing operations, including misalignment of the curve, insufficient track restraint, and failure to reestablish an appropriate neutral rail temperature.

The safety issues addressed in the report are:

- Continuous welded rail temperature control,
- Continuous welded rail restraint, including ballast and rail anchors,
- Continuous welded rail maintenance procedures and standards,
- Means of end-of-train device activation,
- Amtrak passenger accountability procedures, and
- Securement of folding armchairs on Amtrak Superliner sleeper cars.

Other items discussed in the report include:

- Suitability of the Auto Train consist and
- Crashworthiness of Superliner passenger car windows.

As a result of its investigation of this accident, the Safety Board makes safety recommendations to CSXT, Amtrak, the Federal Railroad Administration, and the Transportation Security Administration.

this page intentionally left blank

Factual Information

Accident Synopsis

About 5:08 p.m. eastern daylight time[1] on April 18, 2002, northbound National Railroad Passenger Corporation (Amtrak) train P052-18,[2] the Auto Train, derailed 21 of 40 cars on CSX Transportation (CSXT) track near Crescent City, Florida. (See figure 1 for a map showing the accident location.) The train derailed in a 3-degree, 11-minute left-hand curve while traveling about 56 mph. The train was carrying 413 passengers and 33 Amtrak employees.[3] The derailment resulted in 4 fatalities, 36 serious injuries, and 106 minor injuries. The equipment and track costs associated with the accident totaled about $8.3 million. (See figures 2 through 4 showing the accident aftermath.)

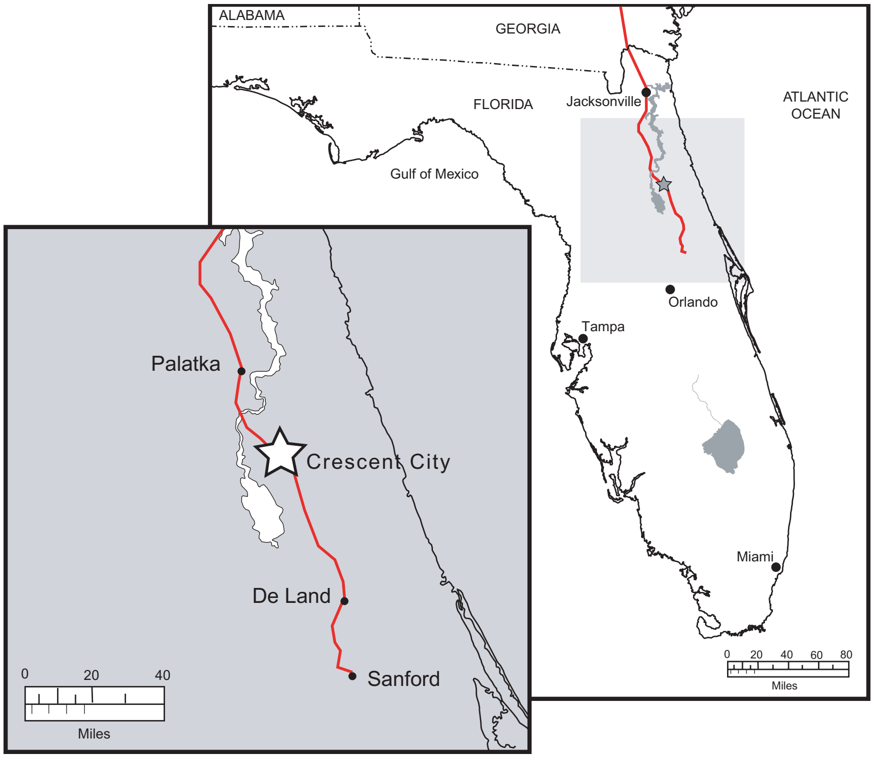


Figure 1. Map showing accident location on CSXT Sanford subdivision. (Insert shows CSXT rail line running north from Sanford. Star marks approximate accident site.)

---

[1] Unless otherwise indicated, all times are eastern daylight time.

[2] "P052-18" stands for Passenger Train number 52 of the 18th (of April).

[3] Of the 33 Amtrak employees on the train, 24 were service personnel, 5 were service managers, and 4 were train-operating crewmembers.

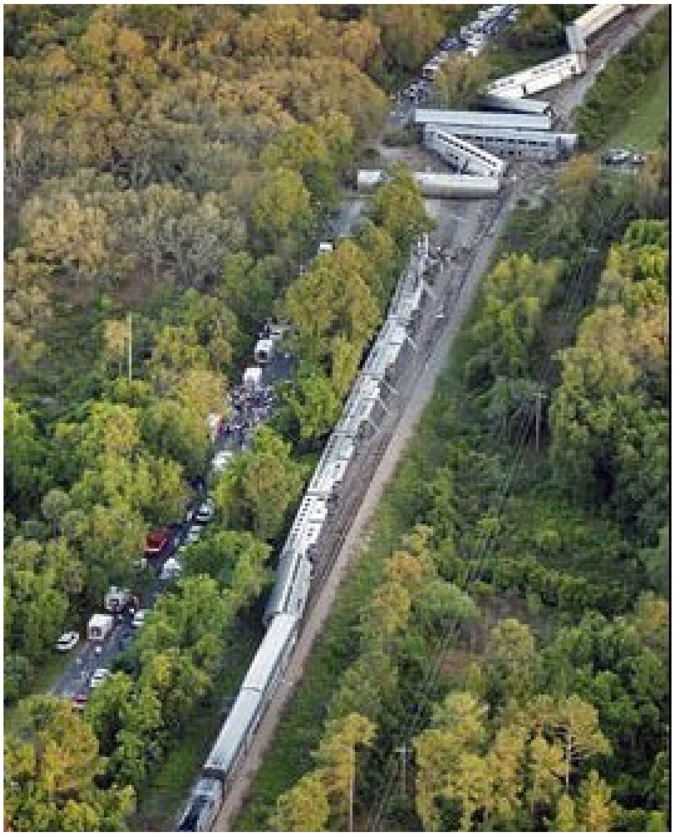


Figure 2. Aerial view of accident site.

Figure 3. View of two cars after the accident.

Figure 4. Figure 4. Panoramic/composite image view of derailed cars. (Photo source: Putnam County Sheriff's Department. Panoramic/composite view developed by the Safety Board.)

Accident Narrative

Northbound Amtrak Auto Train P052-18 originated at Sanford, Florida, on April 18, 2002, bound for Lorton, Virginia. The train consisted of a 2-unit diesel-electric locomotive and 16 Amtrak Superliner passenger cars, followed by 24 loaded Amtrak automobile-carrying "autorack" cars.

According to the Auto Train crewmembers, the train had been assembled before they boarded. Before departure, carmen[4] successfully performed the required Federal Railroad Administration (FRA) initial terminal equipment inspection, a Class I air brake test,[5] and a two-way end-of-train (EOT) device test. The Auto Train operating crew held a job briefing before departure.

The CSXT train dispatcher granted the Auto Train permission to come out of the loading facility and occupy the main track after southbound Amtrak train 97 had cleared the Sanford Station. The Auto Train departed Sanford at 4:08 p.m., 8 minutes behind schedule. The engineer performed a mandatory running air brake test[6] after the train departed the station and noted that the brakes worked as expected. The train-operating crew said that the trip from Sanford until the accident was uneventful and that all equipment functioned normally.

---

[4] Carmen represent a union (Brotherhood of Railway Carmen) craft of Amtrak mechanical department employees who service and maintain the rolling equipment, principally the cars.

[5] See 49 *Code of Federal Regulations* 238.313.

[6] See 49 *Code of Federal Regulations* 238.319.

CSXT dispatcher records showed that the Auto Train had an "out time"[7] at Sanford[8] of 4:17 p.m. The train passed the Benson Junction, De Land, and Barberville Stations at 4:23, 4:35, and 4:44 p.m., respectively. As the train moved northwards, it passed automated hotbox/dragging equipment detectors at Orange City and Barberville, Florida, which detected no defects. The Auto Train arrived at Seville, Florida, at 4:53 p.m. and waited on the mainline for a CSXT southbound coal train (train N16815) to pass. The Auto Train then departed at 5:00 p.m.

Upon leaving Seville, the engineer applied power to accelerate the train to 60 mph, the maximum speed allowed for the curve 3 miles ahead, between mileposts (MPs) 723.0 and 722.2. The train was operating under a clear signal indication[9] from the wayside traffic control signal system. Event recorder data showed that the train was traveling at 56 mph as it approached MP 722.

The engineer said that he was monitoring the progress of the train's acceleration, not wanting to exceed the 60-mph speed restriction. He said that the speed indicator was showing 57 mph. As he looked at the track ahead, he noticed an irregularity in the track alignment just before the locomotive passed over it. He saw that both rails were out of alignment. He described the rails as being parallel to one another and out of line to the right (to the east, or outside, of the curve) by about 10 inches. The engineer said that as he raised his hand toward the controls, he was jarred violently as the engine passed over the misalignment. He said that despite being jolted, he quickly managed to bump the air brake handle and initiate a service application of the train air brakes. According to event recorder information, he initiated an emergency brake application a few seconds later. He activated the two-way EOT device about 15 seconds after initiating the emergency brake application.[10] The 3rd through 23rd (21 total) cars derailed. According to the event recorder, the lead locomotive unit came to a stop about 700 feet from the point at which the engineer made the emergency brake application.

The engineer said that during the derailment, the assistant engineer shouted for him to place the brake handle in emergency. The engineer also heard a radio call from the conductor requesting an emergency brake application.

The assistant engineer said that he was reviewing a train bulletin when the engine passed over the track anomaly. He said that he yelled to the engineer and then activated his

---

[7] *Out time* is not the departure time; it is the time that the train clears the station and interlocking.

[8] Sanford is at milepost (MP) 766.3, as measured from a point midway across the CSXT bridge that spans the James River at Richmond, Virginia, which is MP 0. Technically, all the MPs on this track have an "A" as a prefix, in reference to the predecessor railroad Atlantic Coast Line. For simplicity, in this report, the prefix is omitted in all cases.

[9] A *clear* or *green wayside signal* indicates that the train may travel up to the maximum authorized speed.

[10] The *two-way EOT device* is a telemetry tool attached to the end coupler of the train. The EOT device transmits the brake pipe pressure at the rear of the train to the lead unit (head-end locomotive). The brake pipe pressure can also be seen on a digital readout on the flashing rear-end device itself. A two-way EOT device is also capable of receiving a transmission from the lead unit to open the brake pipe and put the train into emergency.

emergency brake valve. After the train came to a stop, the assistant engineer programmed the radio to the emergency channel for the dispatcher. The engineer told the train dispatcher of the derailment and requested emergency assistance. They had the following exchange:

Engineer: AA --- Emergency radio, over. We have a wreck, milepost 722, P052. We have cars on their side.[11]

AA Dispatcher: Okay. P052, we have a wreck at 722 milepost, cars near the right-of-way or on the right-of-way, over?

Engineer: We were coming around ----, we had a bad kink in the rail.[12]

AA Dispatcher: Okay. P052, I understand those are your cars on the side, over.

Engineer: We have cars on the side. We will need emergency assistance.

AA Dispatcher: Okay, sir. I will get everybody coming.

The engineer and assistant engineer assessed the situation and decided that the engineer would remain on the locomotive to relay radio communications. The assistant engineer went to help the passengers and Amtrak personnel in the derailed cars.

The dispatcher contacted CSXT police and told them of the derailment and the location. After this conversation, the dispatcher called the Auto Train engineer and they had the following exchange:

AA Dispatcher: Okay. I have all the emergency people notified now. Can you give me more information ---- to access it? Over.

Engineer: We were coming around a curve at, the Silver Lake Curve; milepost 722.2, there was a bad kink in the rail. The engine made it over, and about the first four cars made it over and then we got cars piled one on top of the other behind it.

---

[11] "AA" is the CSXT letter designation for the dispatcher who controlled the accident area.

[12] In the railroad industry, the term "kink" (sometimes called a "sun kink") refers to a track buckle. A *track buckle* is an irregularity in track alignment. Track buckles may be caused by a number of conditions; among the causes are rail alignment deviation and the rail's expansive forces exceeding the ballast/track structure's capability to restrain them.

The conductor was riding in the second car at the time of the derailment. He was thrown about the car as it passed over the misaligned track. After the train came to rest, the conductor exited the coach and radioed the engineer to shut down the head-end power.[13]

The assistant conductor was riding in the first dining car, which was the seventh car from the locomotive. The dining cars were open for the evening meal, and patrons were being seated at the time of the derailment. The assistant conductor said that he had just gone downstairs into the lower level of the dining car when the derailment occurred. As the car derailed, it rolled onto its side. The assistant conductor helped passengers and crew climb upward out of the "top" of the overturned dining car through what had been a side door.

Auto Train on-board service employees told passengers what had happened and that emergency services had been called. Some Amtrak employees provided on-scene first aid to passengers. Amtrak employees continued to assist passengers, and emergency service personnel upon their arrival on-scene, until all the passengers had been evacuated and the site secured. Sometime after dark, the train-operating crew was taken to a local hospital for required FRA alcohol and drug tests.[14]

Emergency Response

At 5:09 p.m., the Putnam County 911 operator (Putnam County Dispatch) received a call from the CSXT police dispatcher requesting immediate emergency medical services for an Amtrak train that had overturned in Crescent City. The dispatcher said that no information could be provided on the number of passengers involved. Putnam County dispatched Rescue Unit #6 from Crescent City Fire Station 3 and Putnam County Sheriff Unit A397 to the derailment at 5:10 p.m. Rescue Unit #6 departed for the accident at 5:12 p.m. A minute later, Engine 3 from Crescent City Fire Station 3 was en route to the accident. About the same time, the Volusia County 911 dispatcher transferred a call from an Auto Train passenger to the Putnam County Dispatch. The passenger said that nine passenger cars were on their sides and that some passengers were trapped.

At 5:15 p.m., a Crescent City police officer arrived on-scene at Jaffa Road and State Highway 17. Putnam County Sheriff Unit A397 arrived on-scene at 5:17 p.m. and reported that the accident location was at Old Highway 17 and State Highway 17. About this time, another passenger called the Putnam County Dispatch and reported that the entire train was derailed and overturned. The passenger also said that more than 400 people were on the train and that there were injuries.

The first fire department unit, Engine 3 from Crescent City Fire Station 3, arrived on-scene at 5:18 p.m. At 5:19 p.m., the Volusia County 911 dispatcher transferred another

---

[13] *Head-end power* comes from the electrical generator(s) in the locomotive units that provide all electrical power to the passenger cars for heat, light, and air conditioning.

[14] See 49 *Code of Federal Regulations* Part 219.

call from a passenger on the train to the Putnam County Dispatch. This passenger stated that he could hear sirens, and he told the dispatcher that the emergency responders needed to come through a farm. At 5:20 p.m., the chief of the Crescent City Fire Department arrived on-scene (without his radio, which he had left at the station), assumed incident command, and established a command post on Jaffa Road. The fire chief immediately began to assign the arriving emergency responders various duties and to set up triage and staging areas. The fire chief had never before responded to an emergency of this magnitude, and he walked around the accident scene to evaluate the situation.

At 5:23 p.m., the first arriving paramedic from Rescue Unit #6 reported to Putnam County Dispatch that 468 people were on the train, several of whom were trapped and others who were "walking wounded." Shortly thereafter, the deputy chief of Operations for Putnam County Emergency Services initiated the Putnam County Comprehensive Emergency Management Plan by cellular phone while he was en route to the derailment. (The purpose of the plan is to prepare and respond to a variety of disasters and emergencies that affect the public.) In addition, he notified the State Warning Point,[15] which alerted Florida State agencies to respond to a mass casualty disaster.

From about 5:33 p.m. until his arrival on-scene, the training coordinator for Putnam County Emergency Services attempted to contact the chief of the Crescent City Fire Department but was unsuccessful (because the chief had no radio with him). At 5:40 p.m., the training coordinator arrived on-scene and established a staging area at Clifton Road and Old Highway 17. Having been unable to contact the fire chief, the training coordinator assumed incident command and established a command post at Old Highway 17, south of Clifton Road, at 5:46 p.m. By 7:08 p.m., the training coordinator (incident commander) reported that all passengers had been evacuated except for one entrapped fatality. At 7:19 p.m., the incident commander moved the command post to State Highway 17 and Clifton Road. The incident commander departed the scene at 8:08 a.m. on April 19, which officially ended the emergency response.

A total of 441 emergency responders from 31 agencies took part in the response. Ambulances from eight Florida counties and six medical helicopter services responded to the accident and transported injured passengers to eight area hospitals. Before the passengers were transported, emergency responders performed on-scene triage. State and local law enforcement officers helped emergency responders with the passengers and provided security and traffic control at the accident scene until the derailment was cleared from the track on April 21.

As a result of the Crescent City derailment, the chairman of the Board of County Commissioners for Putnam County declared a state of emergency for the county between April 18 and 25, 2002, (1-week period) and implemented the Putnam County Comprehensive Emergency Management Plan. The Florida Division of Emergency Management had last certified the plan in June 1999, and the Putnam County Board of Commissioners had last certified it in October 1999.

---

[15] The *Florida State Warning Point* is a 24-hour communications center that coordinates all State and local resources during an emergency.

When Safety Board investigators interviewed the training coordinator for Putnam County Emergency Services (incident commander) after the accident, he said that he had had problems getting accurate information from Amtrak about the number of people on the train. He said that soon after he came on-scene, the conductor told him that 468 people were on board the train and gave him a "greeter list."[16] The incident commander said that the conductor also gave him a passenger list that showed the passengers' locations by car and room, but the greeter and passenger lists did not match. He said that he and other emergency responders spent time attempting to verify the accuracy of the two lists. On April 19, Amtrak gave him a computer printout list with information that did not fully correlate with either of the other two lists.

According to Amtrak, at the time of the accident, the passenger accountability procedures described in its *Service Standards Manual for Management Employees* were in place on the Auto Train, as well as its other long-distance, overnight, and reserved trains (including all Metroliner and Acela Express trains).[17] (See appendix B for referenced procedures.) The passenger accountability procedures outlined in this manual, used in conjunction with the information from the updated passenger manifest, are intended "to ensure that the Conductor's Ticket Collections Pouch provides an accurate list of everyone on-board who may not be ticketed or appear on the manifest." Conductors are to fill out form NRPC 3085 for each person who does not have a ticket or does not appear on the manifest. One copy of this form is to be kept in the conductor's ticket collections pouch and another copy is to be given to Amtrak station personnel at the next open, staffed station along the route. The Amtrak station personnel are to use this form to update the passenger manifest in the electronic reservation system.

The incident commander said that he was never provided an accurate count of people on the train. During postaccident interviews, the Auto Train conductor told the deputy chief of Operations for Putnam County Emergency Services that 437 passengers, 3 infants, and 28 crewmembers, for a total of 468 people, had been on the train. By gathering information from Amtrak, Putnam County Emergency Services, and medical records, Safety Board investigators determined, about 5 months after the accident, that 446 people had been on the accident Auto Train.

On June 6, 2002, Amtrak officials conducted a debriefing in Palatka, Florida, with representatives of all the emergency responder agencies involved in the accident, in accordance with 49 *Code of Federal Regulations* (CFR) 239.105. The debriefing had about 80 attendees (including a Safety Board representative) and was intended to determine the effectiveness of the emergency plans that were implemented; to critically review the roles, responsibilities, and performance of the agencies involved; and to

---

[16] A *greeter list* shows the names of all those who made a reservation to travel on that train on that day. When the passengers arrive to board the train, they check in with an Amtrak employee who "greets" them and checks off their names. It is not uncommon for someone to make a reservation for a particular day and then not to show up.

[17] See Amtrak's *Service Standards Reference Manual for Management Employees*, Chapter 16 "Train Service Crew Functions and Accountabilities," Part D "Passenger On-Board Record Procedures," reissued November 2002.

improve emergency planning and response to future accidents and incidents. Although the debriefing minutes prepared by Amtrak do not discuss the issue of passenger accountability, some of the emergency responders involved in the on-scene command structure stated during the debriefing that the emergency responders found it difficult to account for the passengers because of the different lists Amtrak provided.

Injuries

The derailment resulted in 4 passenger fatalities, 35 serious passenger injuries, and 104 minor passenger injuries. Amtrak on-board employees sustained one serious and one minor injury. One emergency responder received a minor injury. (See table 1.)

Table 1. Injuries*

	Amtrak Employees	Emergency Responders	Passengers	Total
Fatal	0	0	4	4
Serious	1	0	35	36
Minor	1	1	104	106
Total	2	1	143	146

* Title 49 CFR 830.2 defines *fatal injury* and *serious injury* as follows: “Fatal injury means any injury which results in death within 30 days of the accident.” “Serious injury means any 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, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface.” The *minor injury* category includes all other persons, not cited in the other injury categories, who were reported treated by area hospitals within 24 hours following the incident.

Damage

The 3rd through 23rd cars derailed during the accident. The first 16 cars in the train behind the locomotive units were Amtrak Superliner passenger cars; these were followed by 24 autorack cars. After the derailment, the locomotive units and first two passenger cars remained on the rails. The next 14 passenger cars and the 7 succeeding autorack cars derailed. The 7 derailed autorack cars remained generally in-line. The remaining 17 autorack cars stayed on the rails. (See figure 5 and table 2 for the postaccident disposition of the 2 locomotive units and the first 23 cars of the train.)

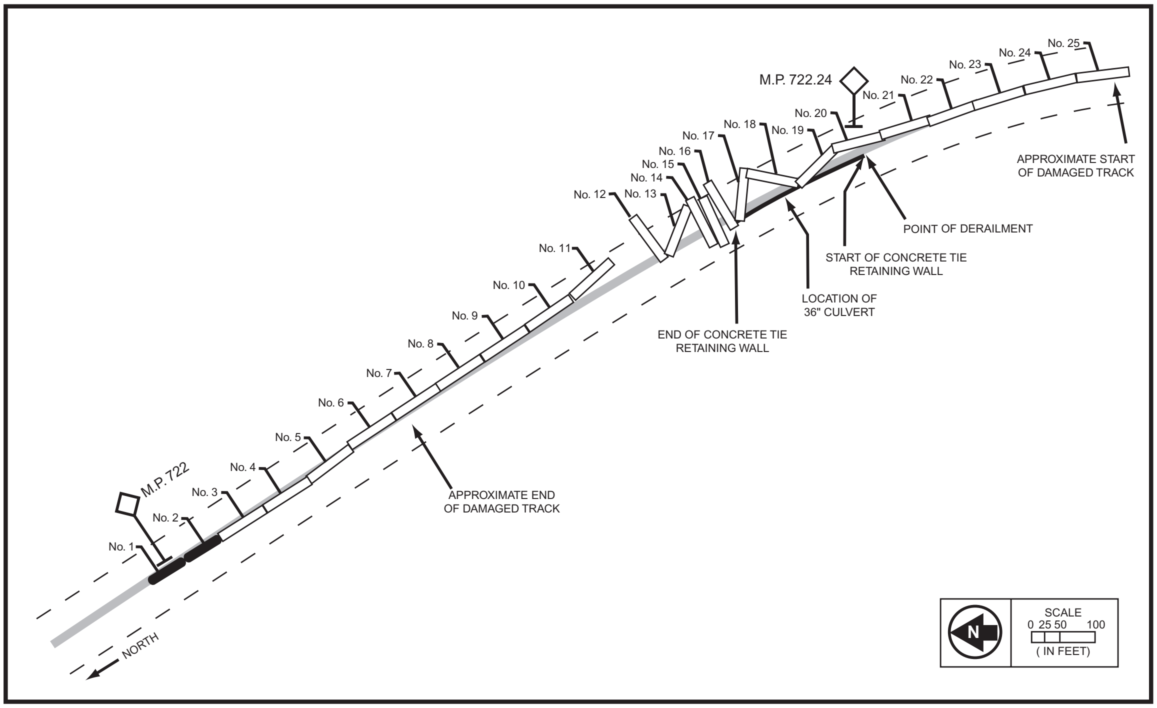


Figure 5. Postaccident disposition of 2 locomotive units and first 23 cars in accident train. (See table 2 for specific information concerning each locomotive unit and car.)

Table 2. Information on postaccident disposition of the locomotive units and first 23 cars of the Auto Train.

Consist Number	Car Number	Car Type	Car Orientation
1	838	Locomotive	Not derailed
2	843	Locomotive	Not derailed
3	39002	Transition Sleeper	Not derailed
4	32502	Sleeper	Not derailed
5	32084	Sleeper	Over right-of-way, leaning to the right
6	32074	Sleeper	Lying on right side, in ditch
7	32503	Sleeper	Lying on right side, in ditch
8	33101	Lounge	Lying on right side, in ditch
9	38052	Diner Car	Lying on right side, in ditch
10	32501	Sleeper	Lying on right side, in ditch
11	32100	Sleeper	Lying on right side, in ditch
12	32090	Sleeper	Lying on left side, perpendicular to right-of-way
13	34129	Coach	Leaning 25°+/- to right, 45°+/- to right-of-way
14	34125	Coach	Upright, perpendicular to right-of-way

15	34126	Coach	Lying on left side, 80°+/- to right-of-way
16	34120	Coach	Leaning 25°+/- to left, 75°+/- to right-of-way
17	33100	Lounge	Leaning 45°+/- to left, 55°+/- to right-of-way
18	38054	Diner Car	Leaning 27°+/- to right, 45°+/- to right-of-way
19	9030	Autorack	Derailed upright, 15°+/- to right-of-way
20	9031	Autorack	Derailed upright, 15°+/- to right-of-way
21	9019	Autorack	Derailed upright, leaning to right
22	9035	Autorack	Derailed upright, over right-of-way
23	9004	Autorack	Derailed upright, over right-of-way
24	9036	Autorack	Derailed upright, over right-of-way
25	9001	Autorack	Derailed upright, over right-of-way

The disposition of the derailed cars, particularly the passenger cars, reflected the accordion effect of railcars when they derail, alternately folding together in parallel fashion, perpendicular to the track. (See figure 6.)

Figure 6. Aerial view of derailment showing accordion effect of derailed cars.

Amtrak estimated the cost of damage to the equipment at $8.13 million. About 1,000 feet of the main track was destroyed during the derailment, which required the installation of 25 1/2 track panels. CSXT estimated the cost of track damage at about $150,000.

Personnel Information

Amtrak Train-Operating Crew

The train-operating crew for the Auto Train reported for duty at the Sanford Auto Train terminal at 3:00 p.m., about 2 hours and 8 minutes before the accident. The train crew[18] for this train was two engineers,[19] a conductor, and an assistant conductor. All train-operating crewmembers except the engineer were regularly assigned to this train. The engineer had been called from the extra list because the regularly assigned engineer was off duty. The 72-hour histories of all the train-operating crewmembers, including the engineer, indicated that their work schedules met Hours of Service Act requirements.[20] Each operating crewmember had been promoted by Amtrak and was qualified over the Auto Train route. Both the engineer and the assistant engineer were certified according to Federal regulations.[21]

CSXT Track Maintenance Personnel

Roadmaster. The roadmaster for this territory was one of seven who reported to the assistant regional track engineer in Jacksonville, Florida. The roadmaster's territory was called "Pecan," and it ran from Palatka to Sanford, Florida. The roadmaster was the local supervisor responsible for track maintenance through the accident area. He supervised an administrative clerk, a section foreman with associated trackmen, and a track inspector. The roadmaster requested, coordinated, and oversaw the surfacing gang foreman when the surfacing gang was in the roadmaster's territory. The roadmaster was responsible for ordering and ensuring that all track material and ballast were available for work to be done.

---

[18] In this report, "train crew" generally refers to the operating crew, including two engineers, the conductor, and the assistant conductor. The term does not include the on-board service managers or the on-board service personnel.

[19] The Auto Train operates with two locomotive engineers. In this report, the engineer of record is referred to as the "engineer," while the other engineer is referred to as the "assistant engineer."

[20] See 49 CFR Part 228.

[21] See 49 CFR Part 240.

The roadmaster was hired as a trackman on May 1, 1962, by a predecessor railroad and promoted to apprentice foreman in 1963. He became a track foreman in 1965, a rail gang supervisor in 1967, and a rail gang foreman 6 months later. In 1970, he was promoted to assistant roadmaster. He was promoted to roadmaster on June 1, 1974. He had been roadmaster for the railroad,[22] including the accident area, since July 1977.

Section Foreman. The section foreman was hired as a trackman on July 13, 1971. He subsequently became an apprentice foreman and then section foreman. He had been section foreman in the vicinity of the accident since 1977.

Surfacing Gang. The surfacing gang was a regional asset and was sent to locations based on roadmaster requests and as directed by the assistant regional track engineer. The surfacing gang foreman was hired as a trackman on May 3, 1971. He had been a surfacing gang foreman since 1978. The foreman was familiar with the accident area. Although there were several surfacing gangs, this surfacing gang usually worked on the Pecan territory, including the vicinity of the accident. The surfacing gang consisted of a Mark III track liner-tamper machine[23] operator, a ballast regulator machine operator, and the surfacing gang foreman.

Track Inspector. The track inspector was hired as a trackman on December 7, 1970. He became an apprentice foreman on March 9, 1971, and a foreman inspector on March 21, 1972. On November 11, 1974, he was promoted to foreman. He was appointed as assistant roadmaster of Baldwin, Florida, on June 1, 1981, and as roadmaster on the Brooksville Subdivision at Tallahassee, Florida, on October 10, 1983. In October 1995, he transferred to the Pecan territory as a trackman. This employee had been the track inspector on the Pecan territory through the accident area for 6 years (since 1996) prior to the accident.

Train Information

Amtrak Auto Train P052-18 was about 4,000 feet long and weighed about 3,227 tons.[24] The train consisted of a 2-unit diesel-electric locomotive[25] followed by 16 Amtrak Superliner passenger cars[26] and 24 loaded Amtrak autorack cars. Superliner cars weigh between 150,000 and 160,000 pounds (unoccupied). Autorack cars are unique to the Auto Train and are of three types: bi-level autocarriers, tri-level autocarriers, and tri-

---

[22] The generic term *railroad* includes the entire system of track, together with stations, land, rolling stock, and other property used in rail transportation.

[23] The Fairmont Mark III machine aligned and tamped the track in one operation.

[24] This was the consist list weight and did not include the two locomotive units. The weight is approximate within 5 percent of actual weight. Passenger and automobile weights are not critical to train operation and handling because passengers and automobiles account for less than 5 percent of total train weight even if the train is fully loaded.

[25] General Electric P40 "Genesis" locomotive units, AMTK 838 and AMTK 843.

[26] Superliners: 8 sleeper cars, 2 dining cars, 2 lounge cars, and 4 coaches.

level van carriers. Of the 24 autorack cars on Auto Train P052-18, 18 were bi-level autocarriers and 6 were tri-level autocarriers. Loaded bi-level autocarriers weigh about 122,000 pounds and loaded tri-level autocarriers weigh about 164,000 pounds.

Superliner cars require electrical power from the locomotive units for air conditioning and lights. Placing the Superliner cars nearest the locomotive units in the Auto Train consist minimizes transmission distance and simplifies connections. Autorack cars do not have conduits and piping because they do not require electricity. Because the autorack cars are typically placed on the end of the train, they do not need to transmit electrical power.

After the accident and prior to further movement, the locomotive units and the nonderailed car air brake systems were tested and inspected according to FRA regulations for Class I (49 CFR 238 Subpart D) and general locomotive (49 CFR 232.105) brake system safety requirements. The derailed cars had damage that precluded meaningful air brake tests, so they were not tested. The locomotive units and the first 2 cars were tested as a single block, and the last 17 autorack cars were tested as another block. The tested locomotives and cars functioned as designed. A review of the maintenance and service records for each Amtrak locomotive unit and car revealed no conditions that would affect dynamic movement.

The train was equipped with a two-way EOT 23404 (Amtrak) Pulse Sentry II telemetry device.[27] (Not all passenger trains are required to have two-way EOT devices. See appendix C for information concerning EOT regulations for passenger trains.) On April 23, 2002, Safety Board investigators tested the accident train EOT equipment at Sanford, Florida. The EOT equipment was mounted on the first postaccident northbound Auto Train, and the test was conducted prior to the train's departure. The test train's lead locomotive unit, AMTK 838, had been the lead unit of the accident train. The EOT device was the same one that had been in place on the end of the accident train. After the initial terminal train air brake test was complete, tests were conducted to evaluate the EOT device. The two-way EOT device functioned as designed by immediately initiating an emergency brake application at the rear of the train when the locomotive EOT device was activated. An additional test was conducted after a service brake application was made, in accordance with the accident event sequence as recorded by the event recorder. Again, the EOT emergency activation took place without delay when the locomotive EOT device was activated.

The cars on the Auto Train had been equipped with a form of electronically activated pneumatic brakes. Amtrak had been using the electronically activated braking system on the Auto Train on a trial basis, but because the system had some reliability problems, it was disconnected and not being used at the time of the accident.

---

[27] The engineer could make an emergency application of the train air brakes using the two-way EOT device by manually activating the EOT switch in the locomotive cab. At the time of the accident, the technology to enable simultaneous, automatic application of the brakes at the end of the train with the engineer's emergency application of the brakes was not available. Since the accident, an automatic emergency EOT application feature has reached the final development stage and may soon be ready for testing and FRA approval for use.

With electronically activated brakes, the signal to apply or release each car's brakes travels much more quickly than it does with traditional pneumatically activated brakes. Electronic activation takes place virtually instantaneously, while pneumatic activation takes place at a speed of about 800 feet per second. The lag time that the pneumatic signal takes to move back through the train to apply (or release) the brakes is eliminated with an electronic signal.

The electronically activated braking system installed on the Auto Train was redundant in that if the electronic system failed, the train could still be operated in normal full pneumatic mode. In addition, to ensure reliability in an emergency, when the Auto Train was operating in the electronically activated braking mode and the engineer placed the brakes in emergency, the signal would be sent pneumatically, in the traditional manner, through the trainline.

Signal Information

The derailment occurred on a single main track in traffic control system territory signaled for movement in both directions, between the north end of control point Seville,[28] MP 725.6, and the south end of control point Huntington, MP 717.8. The traffic control system consisted of Union Switch and Signal (US&S) color-light wayside signals, US&S Model 23A power-operated switch machines, and coded and electronic track circuits controlled by the AA dispatcher in Jacksonville, Florida. Timetables, train bulletins, and wayside signal indications governed the method of operation.

Postaccident investigation included examination of the dispatcher's data log event recorder in Jacksonville and dragging equipment/hot box detector equipment at Orange City (MP 755.4), Barberville (MP 734.7), and Satsuma (MP 711.9).[29] Operational tests were conducted at the south end of Seville (MP 727.5), the north end of Seville (MP 725.6), and north and southbound automatic signal 723. Switch obstruction and point detection tests were performed at the south and north ends of Seville. All signal equipment was found to function as designed.

Track Information

General

The derailment occurred just inside the Putnam County line, near the town of Crescent City on CSXT single main track.[30] Based on the visible on-site evidence, train crew testimony, and event recorder data, the point of derailment was MP 722.24.

---

[28] *Control points* are specific geographic locations used to designate the limits of a train's authority to occupy track.

[29] This location was north of the accident site.

[30] This was the CSXT Sanford Subdivision of the Jacksonville Service Lane.

The bi-directional railroad track was maintained to FRA Class 4 track[31] standards, which permitted a maximum authorized speed of 79 mph for passenger trains and 60 mph for freight trains. There was a permanent speed restriction of 60 mph for passenger trains for the curve where the derailment occurred.[32]

The train derailed in a 3-degree, 11-minute left-hand curve, northbound in the direction of the accident train movement. The total curve was 1,395 feet long and was located between MP 722.41 and MP 722.15. The circular curve body was 651 feet long, with spirals,[33] each 372 feet long, at either end. The outside rail of the curve was designed to be 6 inches higher than the inner rail, which gave the curve a superelevation[34] of 6 inches.

The track was oriented geographically and by timetable in a north-south direction. The elevation or grade of the track through the accident area, from MP 724.08 to MP 721.80, varied between 0.19 percent descending to 0.73 percent ascending.

Preaccident CSXT Inspections

FRA regulations required that the accident area track be inspected twice a week.[35] Employees designated by CSXT and qualified under FRA regulations conducted daily CSXT track inspections through the accident curve.[36] The last preaccident CSXT daily track inspection over this area was conducted by the roadmaster, when he traversed southbound over the derailment area in a Hy-Rail vehicle[37] late in the morning of April 18, 2002. The roadmaster did not note any anomalies. Between 2:30 and 3:30 p.m. that day, the roadmaster also traveled northbound over the derailment area, riding in the locomotive cab of Amtrak train 98. He noted no track deviations in the derailment area at that time.

The CSXT track inspector for the accident curve was responsible for inspecting about 75 miles of track between Sanford and Palatka, Florida. The inspector had a "playbook" based on work-time standards that outlined the amount of time he was expected to spend on any given inspection task in his territory. The inspector stated that he thought he had enough time to conduct his inspections and that if he needed help he could

---

[31] Railroad track is classified from Class 1, the slowest, to Class 9, the fastest, according to the maximum train speed it is designed to carry. The faster and higher the class of track, the heavier the track structure and the lower the tolerances for deviations from FRA regulation standards.

[32] Railroads, like highways, have a general overall speed restriction but also designate lower speed limits for selected areas, such as curves, bridges, etc.

[33] Railroad curves transition from straight or "tangent" track into "spirals" of track of gradually increasing curvature, which lead to the actual circular curve of fixed radius. As a train leaves a curve, the transition is reversed from curve to spiral to tangent.

[34] *Superelevation* is the vertical distance that the outer rail is raised above the inner rail on a curve to resist the centrifugal force of moving trains. Superelevation acts like a banked roadway curve to balance the centrifugal forces.

[35] See 49 CFR 213.233.

[36] See 49 CFR 213.7.

[37] This is an inspection made from a pickup truck or similar road vehicle equipped with retractable railroad wheels so that it can travel along the railroad track.

request and obtain it. He said he inspected mainline track like that through the accident area from a Hy-Rail vehicle traveling 25 to 30 mph, during which time he also inspected parallel tracks, such as sidings. He inspected mainline track twice a week on nonconsecutive days, and he walked designated curves, including the accident curve, once every 3 months.

An FRA track safety specialist reviewed CSXT preaccident track inspection records for the track between Palatka and Sanford for the period from April 2001 through April 18, 2002, as part of the investigation of this accident. Four exceptions were found regarding the track inspection records; the exceptions concerned the records' failure to indicate that the CSXT inspector had been simultaneously inspecting the track being traversed, the siding, and/or the main track.

Track Structure

The track through the accident area consisted of anchored steel continuous welded rail (CWR) on treated wooden ties secured with tie plates[38] and cut spikes. The inside curve rail was 132-pound[39] rail made by Tennessee Steel in 1971 and installed at this location in 1993. The outside curve rail was 136-pound rail made by Bethlehem Steel in 1994 and installed in 1995.

The rail lay on double-shoulder tie plates[40] that were 7 3/4 inches wide and 14 inches long, secured by five 6-inch cut track spikes per tie plate, and distributed as three rail-holding and two plate-holding spikes. The tie plates rested on treated 7-inch by 9-inch wooden ties that were 8 feet, 6 inches long, with an average spacing of 19 1/2 inches between tie centers. The rail was longitudinally restrained by box anchoring[41] every other crosstie. The rail anchors were predominantly Woodings™ spring-clip-type anchors with random Channel Loc™ drive-on-type rail anchors. (See figure 7 for a diagram illustrating the relationship between rail, rail anchors, ties, tie plates, and spikes.)

FRA Track Safety Program and CWR

The FRA regulations covering CWR are at 49 CFR 213.119. Title 49 CFR 213.119, "Continuous Welded Rail, General," states, in part:

> Each track owner with track constructed of CWR shall have in effect and comply with written procedures which address the installation, adjustment, maintenance and inspection of CWR, and a training program for the application of those procedures, which shall be submitted to the FRA by March 22, 1999.

---

[38] *Tie plates* are rectangular pieces of steel placed under the rail to distribute the weight of a train over a greater area of the tie than the base of the rail alone.

[39] Railroad rail is designated by the weight of the rail in a 1-yard length; generally, the heavier the rail, the larger the rail.

[40] A *tie plate shoulder* is a small raised portion of metal that forms a ridge next to the base of a rail to help properly position the tie plate and prevent the rail from shifting laterally.

[41] *Box anchoring* places rail anchors on both rails across from each other against each side of a tie.

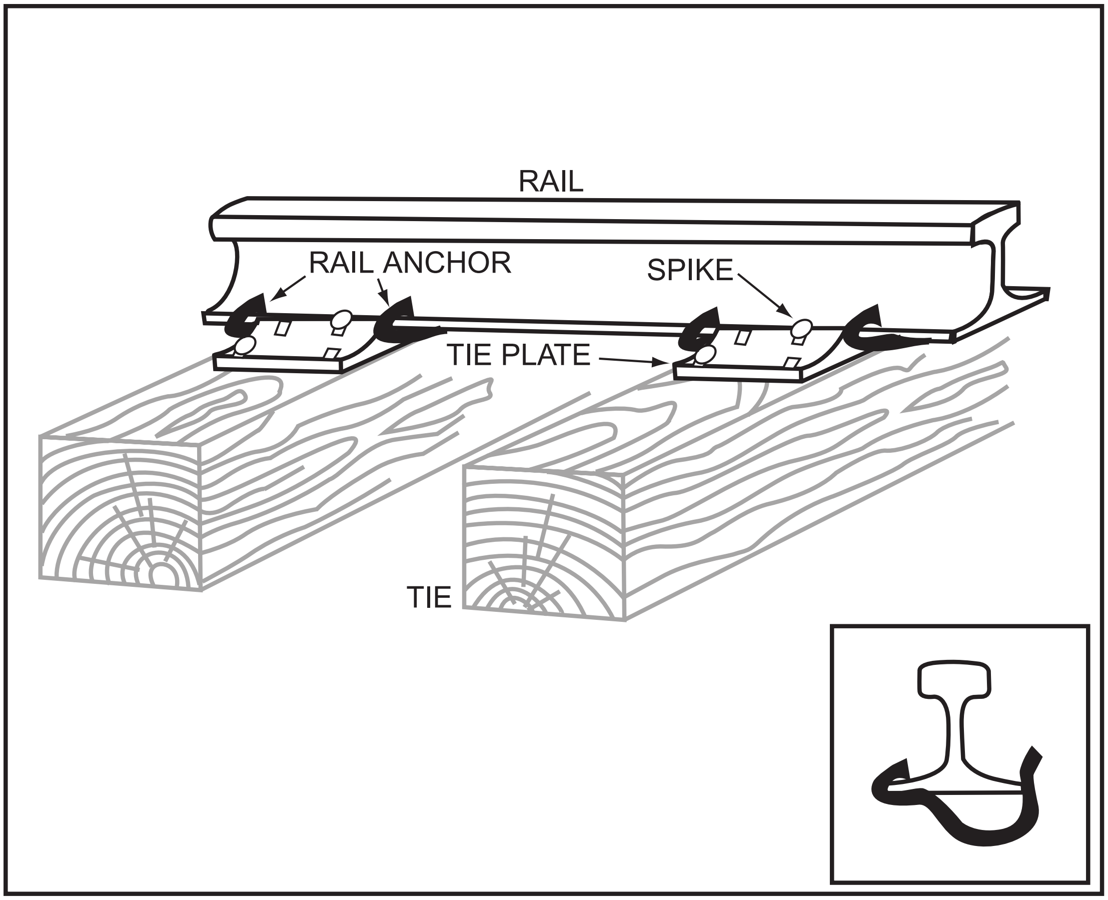


Figure 7. Diagram showing the relationship between ties, rails, tie plates, spikes, and rail anchors. The insert is a cross section showing how the rail anchor grips the rail.

The FRA reviews each plan for compliance with various general principles, which are detailed in the regulations for numerous aspects of CWR use, including installation, adjustment, anchoring, rail temperatures (during installation, repair, and maintenance), monitoring, appropriate speeds, inspection, training for employees working on CWR, and record-keeping, among other issues. The FRA enforces the railroad's own CWR program, as detailed in the railroad's written CWR plan and standards (if any). An FRA violation concerning CWR generally reflects the failure of a railroad to comply with its own CWR standards.

Rail Anchors

Rail anchors are an integral part of the track restraint system for CWR. Rail anchors prevent or restrict the longitudinal movement of the rail, localizing the compressive or expansive forces in the rail and allowing these localized forces to be uniformly distributed throughout the whole track structure. Without the restraint of sufficient, effective, and evenly distributed rail anchors, if ambient temperatures are high, the rail will expand and compressive forces may build up and overcome the lateral restraint at the weakest point in the track, which may create a track buckle. Conversely, in extreme cold weather, unrestrained rail may contract to break at a weak point. To prevent such problems, rail anchors must be in good condition and properly placed. They must also retain their clamping strength and be tight against the side of the tie.

After the accident, Safety Board investigators examined the track that was still intact to the north and south of the point of derailment. Of 1,550 ties inspected, 799 ties were required by CSXT to be box-anchored.[42] Of these, 334 ties were missing one or more anchors or had one or more anchors that were not snug against the ties. Of the total 3,196 anchors required through the area inspected,[43] 622 were judged by postaccident investigators to be missing or not snug against the ties.

In postaccident statements, CSXT track maintenance employees indicated that they considered the rail anchor pattern[44] in the area of the accident curve prior to the derailment to be "standard." The track inspector for the curve stated that "We've got some worn anchors out there but it—generally it was standard. There [were] a few anchors missing here and there." He further stated, regarding the rail anchors, "Nothing, in my opinion, that was dangerous or wouldn't hold, wasn't doing its job, enough of them. There [were] adequate anchors."

Federal Regulations. The FRA requires that railroads with CWR have "rail anchoring or fastening requirements that will provide sufficient restraint to limit longitudinal rail and crosstie movement to the extent practical…."[45]

Industry Practices. With respect to recommended practices for rail anchor application and maintenance, the American Railway Engineering and Maintenance-of-Way Association's (AREMA's)[46] *Manual for Railway Engineering*, published in 2001, states that rail anchors should be "full bearing against the tie or tie plate." In his book *Railroad Engineering,*[47] William W. Hay, Mgt. E., M.S., Ph.D., professor emeritus of railway civil engineering for the University of Illinois, Urbana, Illinois, stated that "If the anchor moves away from the tie, it loses its purpose and should be driven back to its proper position or removed and reapplied." Rail anchor manufacturers instruct users to install rail anchors snug against the tie.

---

[42] There are four anchors per tie (one anchor on each side of a tie for each rail).

[43] Total computed as 799 ties times 4 anchors per tie.

[44] *Rail anchor pattern* refers to the pattern used for distribution of the rail anchors along a section of track. In this case, the rail anchor pattern used was to box-anchor every other tie.

[45] See 49 CFR 213.119(b).

[46] AREMA is an independent industry association that sets recommended standards of practice for railroad construction and maintenance. AREMA's stated purpose is "The development and advancement of both technical and practical knowledge and recommended practices pertaining to the design, construction and maintenance of railway infrastructure."

[47] W.W. Hay, *Railroad Engineering*, 2nd ed., p. 588 (New York, NY: John Wiley and Sons, 1982).

CSXT Standards. According to CSXT Maintenance Bulletin MWI 1113-01, *Performance for Large Scale Track Work*,[48] if the volume of anchor deviations exceeds 1 percent at any 100 consecutive new ties requiring anchors, this qualifies as an anchor defect. Deviations include missing anchors, anchors not snug against ties, anchors not holding, and anchors not installed correctly. Rework limits require remedial action when the number of missing anchors at new ties reduces the standard anchor pattern by 10 percent or more within any 39-foot length of track.

According to the CSXT assistant chief engineer for track maintenance, CSXT's work performance standards for rail anchors noted above apply only to large system-wide production teams; CSXT local maintenance crews are not required to adhere to these standards. Instead, "normal maintenance practices" for crews on the local level are established empirically through on-the-job training. The local roadmaster and/or track inspector perform quality control on these crews' operations as part of their normal duties.

Roadbed

The roadbed is the foundation on which the rails and ties of the track are placed. The roadbed distributes the weight of the train over the earth and provides a firm foundation for the track structure.

The curve through the accident area was built on about 10 feet of earthen fill,[49] which created an embankment for the track to cross a low area. The top of the embankment formed the railroad roadbed. After the accident, CSXT contracted with AMEC Earth and Environmental, Inc., a geotechnical survey group headquartered in Nashville, Tennessee, to take accident curve and embankment soil-boring samples to determine whether any factors that could have weakened the subgrade were present. The borings included samples taken from down the center of the track. The drilling revealed 3 to 5 feet of ballast below the top of the ties, with dense sand underneath.[50] The earth beneath and around the embankment was made up of sand with silt clay and sand over highly plastic clay. The contractor found no zones of extremely loose or soft material in the borings.

The curve embankment was bordered at the base by drainage ditches on each side connected by a drainage culvert through the fill. A 36-inch-diameter cast-iron culvert ran perpendicular to and underneath the track about 150 feet north of the point of derailment (MP 722.24). The culvert had about 7 feet of fill cover above it. The culvert was undamaged and its ends were clear of debris.

---

[48] Specialized non-local work gangs that are maintained at the regional or system level usually perform large-scale track work.

[49] The fill was measured from the ditch line to the top of the subgrade.

[50] These samples were taken after CSXT had widened the roadbed following the accident to accommodate an access road. A 3-D laser survey was also conducted after the accident for roadbed areas just north and south of the accident site. The survey results indicated that the soil-boring findings with respect to embankment depth were representative of preaccident conditions at the accident site. (The engineering firm Phillips & Jordan, Inc., was in charge of the laser survey.)

After the accident, the CSXT chief regional engineer for the Jacksonville District stated that the area of the derailment/culvert had a relatively narrow roadbed. He was also asked if he had any idea how the roadbed became narrow. He stated:

> Well, in a lot of the cases, our roadbeds become narrow because we continue to elevate the track by surfacing our track and raising the track structure. And that narrows up the amount of slope we've got for the retaining of ballast. That's in a lot of cases.

CSXT has no requirement to maintain one specific roadbed width; instead, it requires roadbed widths to be adequate to support the ballast section. CSXT standard engineering plan 2601, "CSXT Roadbed Sections for New Construction," requires a 30-foot roadbed width—15 feet to each side from the centerline of the track at the top of the subgrade—for single main tracks, sidings, and heavy tonnage tracks.

Ballast

The term "ballast section" refers to the total cross-sectional area of the ballast, including the ballast between the ties, under the ties, and off the ends of the ties. The ballast that extends out[51] beyond the ends of the ties at the same height as the tops of the ties and then slopes down to the sub-ballast or roadbed at a "natural" 2 to 1 ratio is called the "shoulder ballast." Based on AREMA testing, the shoulder ballast provides about 20 percent of the track's lateral restraint and the ballast around and underneath the ties accounts for the remaining 80 percent.

The track at the point of the derailment and much of the track through the curve was destroyed in the derailment, which precluded exact measurement of some dimensions of the ballast section. Postaccident observations by Safety Board investigators of the intact track to the north and south of the point of derailment showed that, in many places, the ballast did not fill the tie cribs[52] between the crossties. Many cribs were half full in the center and less than half full toward the ends. There was little or no ballast off the ends of the ties (shoulder ballast), particularly on the inside of the curve. (See figure 8 indicating the ballast condition of track in the area of the accident.)

In postaccident statements, the CSXT chief regional engineer for the Jacksonville District stated that (prior to the installation of a ballast-retaining wall on March 6, 2002) the ballast on the inside of the curve was "lean" and less than the minimum standard but that the outside curve ballast exceeded 12 inches. During postaccident interviews, the CSXT track inspector for the accident curve said that (prior to the installation of a ballast-retaining wall on March 6, 2002) the ballast was not up to standard because it was on a steep embankment. He said, "It wasn't maintained to standards with the 12 inches of ballast on the high side and 6 inches on the low, two-to-one."

---

[51] Perpendicular to the longitudinal axis of the track.

[52] The *tie crib* is the space between two ties.

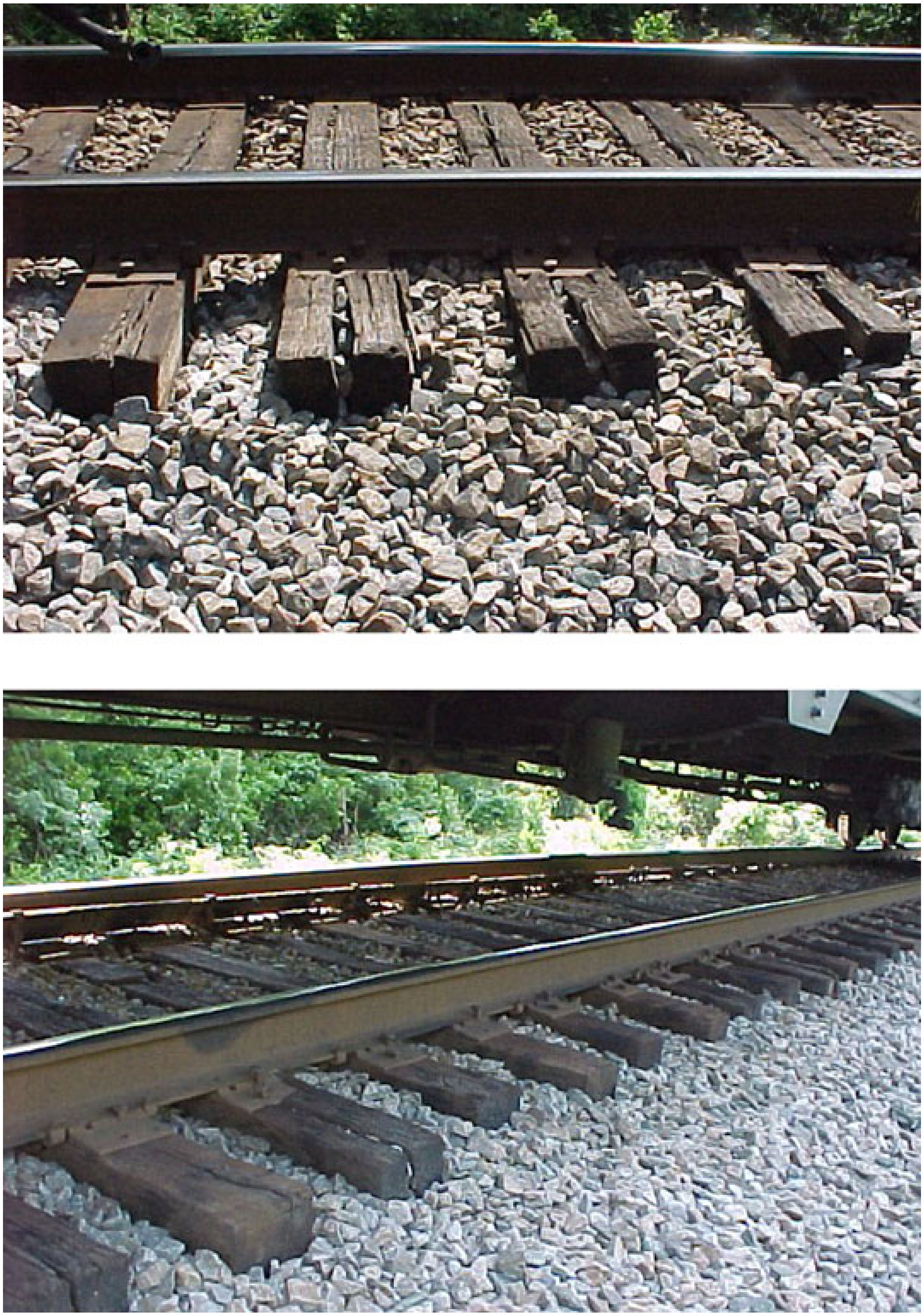


Figure 8. Ballast conditions in accident curve.

FRA Regulations. The FRA regulation regarding ballast (general), 49 CFR 213.103, states:

> Unless it is otherwise structurally supported, all track shall be supported by material which will-
>
> > (a) Transmit and distribute the load of the track and railroad rolling equipment to the subgrade;
> >
> > (b) Restrain the track laterally, longitudinally, and vertically under dynamic loads imposed by railroad rolling equipment and thermal stress exerted by the rails;
> >
> > (c) Provide adequate drainage for the track; and
> >
> > (d) Maintain proper track crosslevel, surface, and alinement.

Industry Practice. The recommended railroad industry practice for ballast in the AREMA *Manual for Railway Engineering*, published in 2001, states:

> *2.1.1.5.2.2, Ballast Section Shoulder Width (BSW)*
>
> The BSW is proportioned in accordance with Chapter 16, Economics of Railway Engineering and Operations, Part 10, Construction and Maintenance Operations and is to provide additional lateral strength to the track.
>
> The measure is made from the end of the crosstie to the point of beginning of the Ballast Side Slope (BSS), and is made in the plane of the top of the crosstie.
>
> A value for BSW of not less than 12-inches is recommended for standard gage construction of CWR in main track service or as may be defined by individual railway company standards.
>
> *2.1.1.5.2.3, Ballast Side Slope*
>
> The BSS run component of the ballast section is proportioned to provide confining pressure to that part of the ballast section expected to transmit the vertical load from the bottom of the crosstie to the top of the sub-ballast.
>
> The BSS run component is measured in the plane of the top of the crosstie, and the rise component is measured perpendicular to the run component.
>
> A BSS value of 2:1 is commonly used.

CSXT Standards. The *CSXT Engineering Department Field Manual*, dated July 21, 2000, page 13, Subpart D – "Track Structure, Parts a, b, c, and d, 103.0.0 Ballast; General," states:

> Ballast section will be maintained in accordance with Standard Plan 2602 with particular attention to maintaining proper ballast section and drainage at or around road crossings, turnouts, and rail crossings at grade.

CSXT Standard Engineering Plan 2602 requires that the ballast shoulder extend 6 inches straight out from the end (and level with the top) of the ties to the shoulder slope on tangent (straight) track and on the inside of curves, and 12 inches on the outside of curves. The 12-inch (outside curve) width is to continue into the tangent at each end of the curve for 100 feet and then to taper to 6 inches in the succeeding 50 feet.

Track Maintenance

Shoulder Ballast Cleaning. From September 18 through October 13, 2000, CSXT conducted shoulder ballast cleaning operations on the railroad, including the curve through the accident area. The shoulder ballast cleaning was intended to improve the drainage of the track. Fouled or clogged ballast can trap water and create soft spots under the track. In some soil conditions, like those found in the coral sand of Florida, the fouling material can also form a hardpan of cement-like material. A shoulder ballast cleaning machine removes fouled ballast from the shoulder area of the track, cleans the ballast, and returns the cleaned ballast to the shoulder, allowing water to drain out and away from the track.

Within a few months of the fall 2000 CSXT shoulder ballast cleaning, the track through the accident area experienced ballast retention problems that prompted CSXT maintenance activities. (See appendix D for a chronological list of track maintenance operations on the accident curve following the shoulder ballast cleaning.) According to the local CSXT track supervisors and inspector, the ballast was migrating down the inside of the curve embankment. No problems were recorded concerning ballast retention on the outside of the curve. Because of the loss of ballast on the inside, the tie ends to the inside of the curve would drop, causing the outside tie ends to rotate upwards, increasing the superelevation.

Surfacing. Surfacing is the process of raising the track and leveling it on the roadbed while simultaneously aligning it into place. The surfacing process is typically accompanied by the addition of new ballast and/or the reapplication of ballast recovered from off the sides of the track, which is then tamped between and around the ties. Between January 2001 and April 18, 2002, CSXT maintenance crews repeatedly surfaced the accident curve to reestablish the correct superelevation and maintain the track geometry.

The regional surfacing gang mechanically surfaced the track through the accident curve with a track liner-tamper machine[53] (and ballast regulator) on October 9 and 11, 2001; November 19, 2001; February 26, 2002; and March 11, 2002. On at least four occasions between October 2001 and April 18, 2002, local track maintenance crews spot-surfaced[54] the track using hand-powered tamping tools. When the surfacing gang foreman was asked after the accident if it was unusual to surface the same area of track repeatedly within 6 months, he said it was “not really standard” and “that would indicate a problem.”

---

[53] The Mark III track liner-tamper machine used in this area aligned and tamped the track in one operation.

[54] *Spot-surfacing* refers to surfacing parts or short sections of track.

On October 9, 2001, the regional CSXT surfacing gang began surfacing the accident curve, starting south of the southern end of the curve and moving north (MP 722.5 though MP 722.1).[55] This was the only time in the 7 months preceding the accident that the entire curve was surfaced. All subsequent surfacing operations on the curve consisted of surfacing shorter sections of track. The surfacing gang foreman stated that the entire curve was to be surfaced with a 1-inch raise, using available ballast from the track. At the time of the work, the rail temperature was noted as 92° F.

After the track liner-tamper machine had measured the curve and the ballast regulator had made an initial pass, the liner-tamper machine surfaced and aligned the south spiral of the curve and the curve itself. Upon beginning the north spiral, the foreman noticed that the track liner-tamper machine was not lining the track properly. He said that the machine was taking the north end of the curve too much to the outside. The foreman made some manual adjustments to line the track back toward the inside of the curve, and the surfacing gang used the liner-tamper machine to line the track in the manual mode. A 25-mph slow order was then placed on the track in that area.

After the track liner-tamper machine was repaired, the surfacing gang returned 2 days later, on October 11, to finish and reline the north end of the curve, beginning around where the gang members had initially noticed the problem with the machine. The surfacing gang foreman stated that the machine double-tamped the ties (on a single pass of the machine) and that the gang was able to get 6 inches of ballast on the inside of the curve. This work involved the end of the curve and the north curve spiral for about 450 feet. After the accident, the surfacing gang foreman was asked if he felt confident the curve had been put back in its proper position and alignment by this surfacing work. The foreman replied, “No, sir, I don’t feel that we got the curve back to where it was supposed to be. That’s the reason why I recommended that they leave the 25-mile-an-hour slow order on there.” The foreman further stated that to properly prepare the curve for 60-mph traffic, the entire curve needed to be relined.

On November 19, 2001, the surfacing gang machine spot-surfaced portions of track near the north end of the curve (about MP 722.21 to MP 722.1). The foreman said, “I think that we mainly started in the body of the curve and come to the north end.” The gang did not reline the entire curve. The foreman recorded an ambient temperature of 75° F and a rail temperature of 83° F. Following this work, the slow order for this area was removed.

All surfacing requires breaking the tie-ballast bond when the track is raised and aligned. As such, surfacing “disturbs” the track. According to CSXT rules at the time of the accident, a “Track Disturbance Report” must be filled out and submitted at the end of the month whenever the track is disturbed (such as when rail repairs, tie installation, or surfacing is conducted) if the rail temperature is below 100° F in a geographic region

---

[55] A CSXT assistant track inspector stated that he unloaded 6 to 8 carloads of ballast in the curve in October 2001, prior to the October 9, 2001, surfacing operation. The section foreman stated that he unloaded an estimated three cars of ballast in the curve sometime during 2001. The exact locations of the ballast applications were not identified in either case. CSXT did not provide the Safety Board with written documentation verifying that these ballast applications had taken place.

south of North Carolina and Tennessee.[56] The roadmaster uses the reports to identify areas that need additional attention, and the reports may be used for follow-up rail adjustment. No Track Disturbance Reports were filed with CSXT for the October and November surfacing operations. The surfacing gang foreman stated that he completed Track Disturbance Reports for the October and November 2001 work, but he did not submit the reports at the end of each month as required.

On February 5, 2002, hand-tamped surfacing was conducted for MP 722.3 through MP 722.1. As a consequence of this work, a slow order was established for MP 722.3 though MP 722.1. This slow order remained in effect through March 13, 2002, because of successive maintenance activities on this section of the track during this period.

On February 26, 2002, the regional surfacing gang, under the supervision of the local section foreman,[57] performed more machine spot-surfacing on the accident curve from MP 722.3 through MP 722.1. According to the section foreman, they tamped the track twice "because it would not stay up." The recorded rail temperature was 90° F, and the ambient high and low temperatures that day were 75° and 45° F, respectively.

Section 119.786 of the *CSXT Engineering Department Field Manual* states that "Where a curve over 1° in CWR track will be disturbed at a rail temperature of 50° F or below, the Roadmaster or his designated representative will set reference stakes within the area to be disturbed at [specified locations] before work is performed." Using the reference points provided by the stakes, the roadmaster is to record the amount of movement between 10 and 15 days after the work has been completed. The term "monumenting"[58] is often used to describe such activities.

In accordance with section 119.786, the track was not monumented during the February 26 surfacing work. On February 27, the ambient high and low temperatures for the area were 68° and 36° F, respectively. By February 28, the ambient high and low temperatures for the accident area were 55° and 36° F, respectively. During a postaccident interview, the assistant chief engineer for track maintenance stated, "In retrospect, had it been recognized that the temperature could possibly get that low the night the track was surfaced [the night of February 26 and 27], we could possibly have gone out and staked the track." He further stated, "If you don't monument the track prior to the work being done, you've lost any legitimate reference point. You know, you can't reference back to something after you've changed it."

The CSXT chief regional engineer for the Jacksonville District stated that he had inspected the derailment curve with the roadmaster and the regional engineer on March 1, 2002. He said he was briefed on a plan of building a "ballast-retaining wall" in early March 2002, and he was asked his opinion. He said he thought it was worth attempting.

---

[56] North of these geographical limits, a Track Disturbance Report would be required if the track were disturbed and the rail temperature were below 90° F.

[57] The local section foreman substituted for the surfacing gang foreman, who was in training.

[58] *Monumenting* consists of establishing known reference points against which any subsequent movement of the track can be measured.

On March 6, 2002, the track inspector had the local track maintenance personnel construct a ballast-retaining wall of used concrete ties along the inside of the curve. Regional engineering managers were aware of this operation. Used concrete crossties were placed on the inside of the curve about 4 feet below the track level (the embankment was about 10 feet high at this location) to form a shallow, ballast-retaining wall. Concrete crossties were stacked 2 ties high (creating a wall about 16 inches high) end-to-end on the inside of the curve down from the toe of the shoulder ballast slope for about 240 feet along the track. The concrete ties were not secured into the embankment. (The point of derailment was near the south end of the ballast-retaining wall.) A number of CSXT maintenance and management personnel familiar with this section of track indicated that the ballast-retaining wall appeared to prevent further ballast migration down the slope. They also indicated that the ballast section on the curve was holding to standard after the wall was constructed. (See figure 9 for a representation of the relative location of the ballast-retaining wall, showing the general relationship between various roadbed and track elements.)

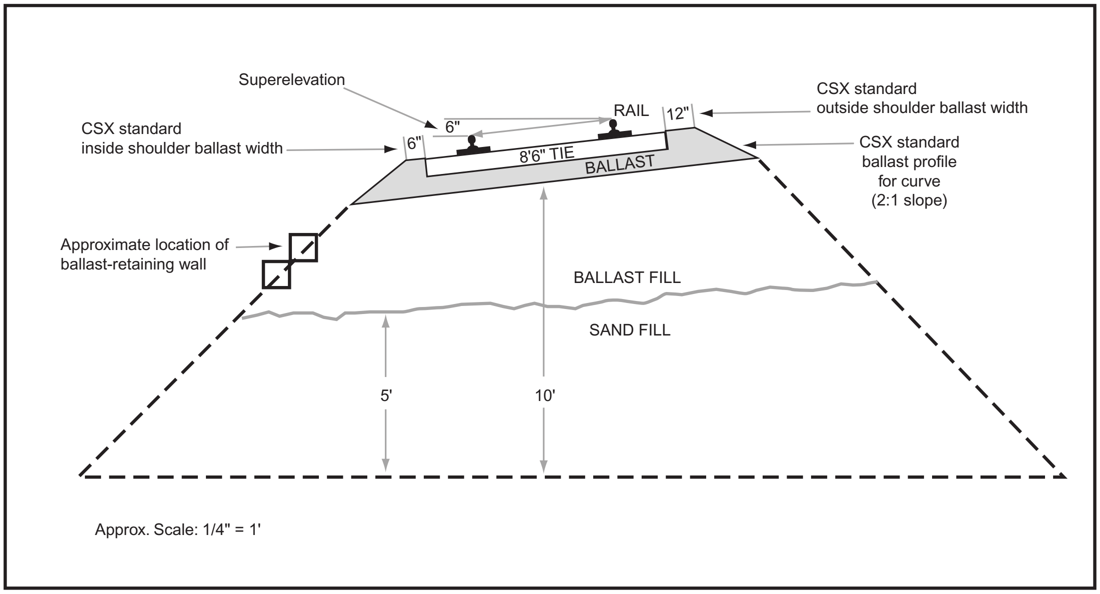


Figure 9. Conceptual drawing of cross section of the roadbed in the accident curve showing the estimated location of the ballast-retaining wall, as well as some roadbed, track, and ballast section elements.

On March 8, 2002, three-quarters of a hopper car of ballast, about 70 tons, was spread on the north end of the accident curve. (The section foreman's personal notes documented this ballast application.)

On March 11, 2002, the regional surfacing gang conducted machine spot-surfacing from MP 722.3 to MP 722.2.[59] During this operation, the surfacing gang used the ballast

---

[59] Because no Track Disturbance Report was filed on this work, this information came from the surfacing gang foreman's notes.

that had been deposited on March 8 to help establish the track. The liner-tamper machine started in the body of the curve and moved northward through the spiral of the curve to create a 1-inch lift. Because the surfacing gang foreman "forgot to make out a Track Disturbance Report," he did not record any rail temperature. (See figure 10 for a visual representation of the relative locations of the surfacing work carried out on the curve between October 9, 2001, and March 11, 2002.)

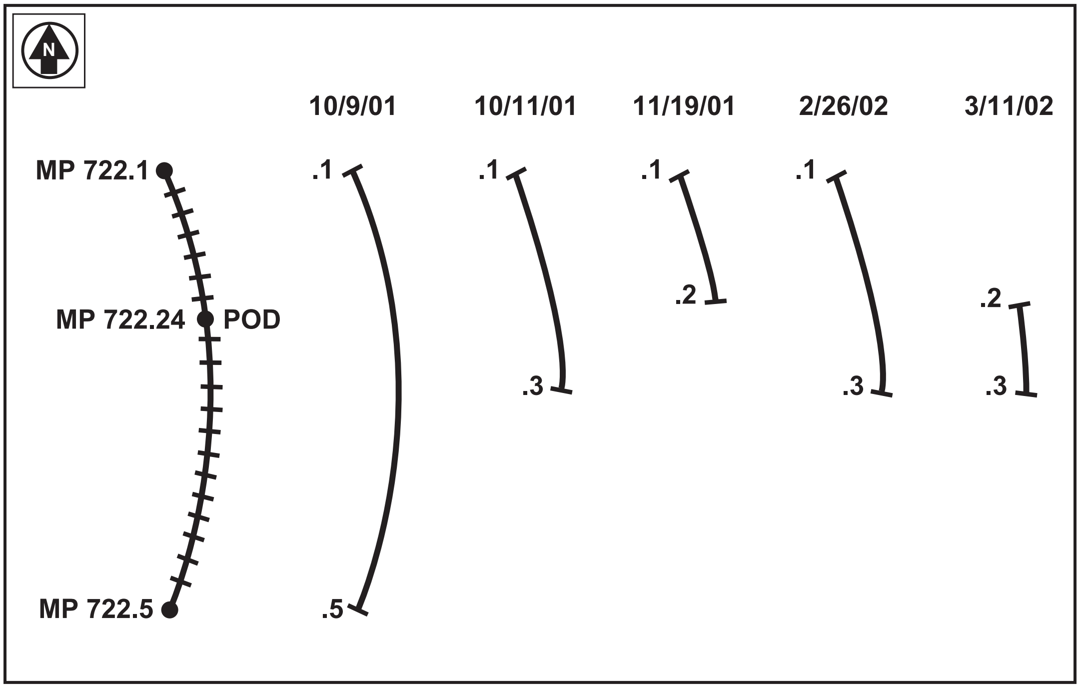


Figure 10. Relative locations of machine surfacing operations conducted on the accident curve between October 9, 2001, and March 11, 2002.

The Florida Department of Transportation railroad track safety inspector walked the accident curve on April 8, 2002, before conducting a Hy-Rail track inspection on April 9, which was his last inspection in the accident area before the derailment. He said that during his walking inspection, he found an area[60] where crossties needed to be replaced, and he contacted the CSXT track inspector. The CSXT track inspector placed speed restrictions of 30 mph for passenger trains and 25 mph for freight trains over the affected track. The Palatka track maintenance crew repaired the track by installing five crossties the same day at MP 722.4. After replacing the ties, the maintenance employees spot-surfaced the area, hand-tamped the ballast, and dressed it with a backhoe and by hand. The section foreman recorded the rail temperature as 92° F. During his April 8 and 9 inspections, the Florida Department of Transportation railroad track safety inspector noted no exceptions to the track ballast or rail anchor conditions, and he did not note any rail movement.

---

[60] About 300 feet south of the subsequent point of derailment.

Postaccident FRA and State Track Inspections

After the accident, it was not possible to inspect the track at or about the point of derailment (MP 722.24) because the track structure was destroyed.

However, an FRA track safety specialist inspected the CSXT track in the accident area to the south of the derailment, from MP 723.0 to MP 722.3, and found 22 exceptions or defects that did not meet FRA Class 4 Track Safety Standards. Four of the exceptions were for more than the allowable number of defective ties per 39 feet of straight track. Three of these four exceptions were located between MP 723.0 and MP 722.8, with the fourth at MP 722.3. Seven other exceptions were for more than the allowable number of defective ties per 39 feet of curved track (greater than 2 degrees) between MP 722.7 and MP 722.6. Based on these exceptions, FRA regulations required the track classification to be reduced to Class 3 for the affected areas. Eleven exceptions were noted for a metal object between the base of the rail and the tie plate, which would cause an undesirable concentrated load. These exceptions were spread over the .7 mile of track inspected, and FRA regulations required the track classification to be reduced to Class 2 for the affected area.

A Florida Department of Transportation track safety inspector inspected the track from MP 722.0 to MP 721.5 (north of the point of derailment) after the accident, and he found five track defects that did not meet FRA Class 4 Track Safety Standards. All five of these track defects were for a metal object between the base of the rail and the tie plate (tie plate shoulder). FRA regulations required that the track classification be reduced to Class 2 within the affected area.

CWR Temperature Control

CWR is subject to mechanically induced outside forces when loaded and to thermally induced internal forces from expansion or contraction. CWR must be longitudinally restrained to prevent rail movement caused by these mechanical and thermal forces. Longitudinal restraint in CWR generally takes the form of additional rail anchors and ballast; elastic clips in lieu of rail-holding spikes; and/or more, larger, or heavier ties.

When the longitudinal mechanical and thermal compressive forces in CWR build to a point at which they exceed the track structure's ability to restrain them, a track buckle will occur. According to AREMA, the magnitude of force that may be developed within CWR, independent of its length, is the product of the difference in temperature between the "neutral rail temperature"[61] and the current rail temperature, multiplied by the cross-sectional area of the rail and the factor of 195 pounds per square inch (psi).[62] In the daytime, rail temperature is commonly about 30° F above the ambient temperature.

---

[61] This is the same as the anchoring temperature.

[62] The internal stress of restrained rail is the product of the coefficient of expansion and the modulus of elasticity of the steel, times the change in temperature.

Thermally induced longitudinal rail forces result when restrained CWR seeks to expand or contract beyond its force-free or neutral rail temperature state. The neutral rail temperature is the temperature of the steel rail under conditions free of internal forces due to thermal stress or strain. Because any difference in rail temperature from the initial laying (or adjusting) temperature, when the rail is anchored or restrained, determines the magnitude of the thermally induced internal longitudinal rail forces, the proper selection and control of CWR installation temperature is very important. Consequently, each railroad develops its own well-defined CWR installation—or neutral rail—temperatures for different geographical and climatic locations. These temperatures are intended to minimize the thermally induced internal longitudinal rail forces throughout the range of seasonal temperature change. The CSXT neutral rail temperature for the accident area was 100° F.

If the rail temperature is below the designated neutral temperature at the time of CWR installation, the rails are artificially heated to the neutral temperature and then immediately anchored. Conversely, if the rail temperature at the time of CWR installation is above the neutral rail temperature, the rail is cooled, usually by spraying it with a coolant, and then anchored.

Without track maintenance, neutral rail temperature will change over time due to movement of the track as the track structure degrades due to the effects of rail traffic and weather. Curved track is more susceptible than straight track to changes in neutral rail temperature. Theoretically, properly constructed and maintained CWR track should not move, and neutral rail temperature should remain unchanged. However, on a practical basis, some movement usually occurs, particularly in curves. The centrifugal forces produced by trains traveling around a curve and the thermal movement of the track (often called "breathing") with seasonal temperature variation will change the neutral rail temperature. It is common for railroads to realign some curves and adjust the rail every spring because track will not expand exactly back to the position it held before it contracted during the winter, thus altering the rail's free force or neutral temperature condition.

Neutral rail temperature can also change as a result of maintenance activities such as surfacing. As has been described, surfacing involves raising the track and leveling the roadbed on which it rests and then aligning the track back into place. Raising the track from the roadbed breaks the restraining bond of the ties and the ballast, which allows the rail to expand or contract to a new force-free neutral rail temperature.[63] If the surfacing involves a length of track that is five or fewer ties long ("spot surfacing"), the neutral rail temperature may not significantly change. However, if the surfacing involves longer lengths of track, the force-free or neutral temperature will likely change significantly, especially if the difference between the current rail temperature and the designated neutral rail temperature is great. Under such circumstances, the CWR should be adjusted.

---

[63] Even though the rail may still be anchored, the rail of the lifted track is free of restraint because only the ties and anchors are attached to the freed rail. Nothing restrains the rail's longitudinal movement.

Rail is adjusted by removing rail anchors, heating or cooling the rail and/or adding or removing small sections of rail, and then reanchoring the rail. The rail in curved track can also be adjusted by lining the curve outwards. Failure to adjust rail that has been disturbed may result in a track buckle later when the weather becomes warm enough that the difference between the new force-free (neutral) rail temperature and the current rail temperature is so great that the track structure cannot be restrained.

Railroads attempt to adjust rail that has undergone documented maintenance activities at the earliest opportunity (usually in the spring before the first hot weather occurs). According to the CSXT roadmaster for the Crescent City accident area, local track maintenance forces usually start adjusting rail that has been disturbed during the winter season when the ambient temperature starts to warm to the upper 80s (° F), usually in April.

Operations Information

The derailment occurred on the CSXT Sanford Subdivision, which was controlled by the CSXT train dispatcher in Jacksonville, Florida.

The Auto Train is listed on Amtrak train schedules as train Nos. 52 and 53. Two Auto Train train sets travel between Sanford, Florida, and Lorton, Virginia; one train runs each way daily. The northbound schedule calls for a departure from Sanford at 4:00 p.m. for an arrival in Lorton at 8:30 a.m. the next day. Auto Trains make no scheduled intermediate station stops, except to change operating crewmembers at Florence, South Carolina.

Including the Auto Train, Amtrak operates seven scheduled passenger trains on the CSXT Sanford Subdivision each day, Monday through Saturday. Six trains are operated on Sunday. Four of these trains, Nos. 91 and 92 (the *Silver Star*) and Nos. 97 and 98 (the *Silver Meteor*), operate between New York City and Miami, Florida. These trains are similar to each other in equipment and consist. Train Nos. 1 and 2 (the *Sunset Limited*) are operated between Orlando, Florida, and Los Angeles, California. These trains run on alternating days, No. 1 on Tuesdays, Thursdays, and Saturdays; No. 2 on Mondays, Wednesdays, and Fridays.

Passenger traffic through the accident area totaled 48 trains per week, while freight traffic totaled 74 trains per week. Freight train traffic volume for the 12 months before the accident was 18.89 million gross tons. CSXT classified this track as heavy tonnage track.

The closest passenger station to the accident location is Palatka, Florida, which is about 24.2 miles north of the accident location. De Land, Florida, which is the nearest passenger station to the south, is about 27.8 miles from the accident site.

Meteorological Information

At 4:53 p.m. on April 18, 2002, the weather conditions at Daytona Beach (about 28 nautical miles from Crescent City) were reported by the National Climatic Data Center as: winds at 9 knots with gusts to 15 knots; visibility 10 miles; few clouds at 3,000 feet; temperature of 80.6° F. By 5:53 p.m., the temperature had fallen to 78.8° F. The day was mostly sunny.

On April 20, 2002, at 2:42 p.m., the rail temperature at the accident site area was recorded as 120° F, and the ambient temperature was 88° F. The day was partly sunny. On April 24, 2002, at 5:00 p.m., the rail temperature was measured at 108° F, and the ambient temperature was 83° F. The day was partly sunny.

On April 25, 2002, at 1:00 p.m., the rail temperature was 108° F, and the ambient temperature was 86° F. At 2:00 p.m., the rail temperature was 120° F, and the ambient temperature was 86° F. At 5:00 p.m., the rail temperature was 120° F, and the ambient temperature was 87.8° F. The day was partly sunny.

Between April 1 and April 18, 2002, maximum daily high temperatures in the Crescent City area ranged from 73° to 89° F. The minimum daily low temperatures ranged from 57° to 71° F. In the days immediately following the accident, the expected high temperatures ranged from 83° to 88° F.

Table 3 shows the high and low temperatures in the Crescent City area for each of the days when the curve was mechanically surfaced—October 9 and 11, and November 19, 2001; and February 26 and March 11, 2002—as well as for the 3 days following each surfacing operation.

Table 3. High and low temperatures recorded in the Crescent City area for the days when surfacing work took place on the accident curve (in boldface) and the 3 days following each surfacing operation. (Source: Record of River and Climatological Observations, National Climatic Data Center, Asheville, North Carolina.)

Day	High Temperature (° F)	Low Temperature (° F)
October 9, 2001	81*	71*
October 10	79	61
October 11	87	64
October 12	80	64
October 13	89	70
October 14	84	64
November 19, 2001	75	58
November 20	71	57
November 21	75	57
November 22	77	61
February 26, 2002	75	45
February 27	68	36
February 28	55	36
March 1	66	48
March 11, 2002	74	53
March 12	84	56
March 13	79	54
March 14	78	54

* Asterisk indicates that temperatures were recorded at Daytona Beach, Florida, rather than Crescent City, Florida.

Toxicological Information

Complete medical records for the Amtrak Auto Train engineer and assistant engineer were obtained from Amtrak and provided to the Safety Board's Medical Officer for review. No medical condition or use of prescription medication likely to cause performance degradation was found.

The four members of the train's operating crew provided blood and urine samples for toxicological testing pursuant to 49 CFR Part 219, Subpart C. Northwest Drug Testing of Salt Lake City, Utah, conducted the testing. Samples were screened for cannabinoids, cocaine, opiates, amphetamines, methamphetamines, phencyclidine, barbiturates, benzodiazepines, and ethyl alcohol. All results were negative for the presence of alcohol and cited drugs.

Disaster Preparedness

Area Emergency Response Training

On December 17, 1991, Amtrak train 87, the *Silver Meteor*, derailed in Palatka, Florida, which, like Crescent City, is in Putnam County. The derailed train struck two homes and blocked the street north of the Palatka Station.[64] There were no fatalities. Eleven passengers were seriously injured and 41 sustained minor injuries. Five operating crewmembers and four on-board service employees sustained minor injuries. Because of this prior Amtrak accident in the area, some emergency responders were already somewhat familiar with Amtrak equipment.

On September 19, 1997, an Amtrak emergency preparedness manager provided Passenger Train Emergency Response training[65] to 63 members of various emergency response agencies in Putnam County. Personnel who received the Amtrak training and responded to the Crescent City derailment included the chief of the Crescent City Fire Department, who was the initial incident commander; the training coordinator for Putnam County Emergency Services, who was the final incident commander; and the Putnam County Sheriff's Office communications captain. Amtrak subsequently provided similar training to emergency responders from the surrounding counties.

Amtrak Personnel Emergency Preparedness Training

Amtrak has developed an emergency preparedness training program for its crewmembers as required by 49 CFR Part 239. Amtrak has named this training program "PREPARE" (Passenger Railroad Emergency Preparedness And Response Education). The purpose of this 8-hour course is to prepare operating crewmembers and on-board employees to respond to a train emergency.

Amtrak provided Safety Board investigators with the emergency preparedness training records for all the Amtrak employees on the accident train. According to these records, all four operating crewmembers[66] had attended the PREPARE training in the 3 months prior to the accident. Of the 24 Amtrak on-board service personnel, 17 had received Amtrak's PREPARE training between January and March 2002, 5 had received the training in December 2000, and 1 received the training in April 2000. One on-board service person did not receive the PREPARE training prior to the accident.

---

[64] National Transportation Safety Board, *Palatka, Florida, December 17, 1991*, Railroad Accident Report NTSB/RAR-93/02* (Washington, DC: NTSB, 1993).

[65] SAFE 015 course.

[66] Engineer, assistant engineer, conductor, and assistant conductor.

Auto Train Event Recorder Information

Each Auto Train locomotive unit event recorder was downloaded shortly after the accident, and investigators noted the times of the recorded events as indicated by the EOT device and the locomotive event recorders. Event recorder data from both the lead locomotive, AMTK 838, and the trailing unit, AMTK 843, indicated that the train was moving at 56 mph at the time of the initial brake application as the train approached MP 722.

During the accident sequence, the event recorder on the lead locomotive unit recorded the trainline pressure at the rear of the train that was transmitted by the EOT telemetry device. The trainline air pressure at the end of the Auto Train was stable at 108 psi[67] for several seconds after the first locomotive passed over the track buckle at 5:07:54 p.m.

According to the event recorder information, the engineer initiated a service brake application at 5:07:57 p.m. He initiated an emergency brake application at the head end of the train at 5:08:01 p.m. By 5:08:02 p.m., the trainline pressure at the head of the train was 98 psi, the rear-end trainline pressure was 108 psi, and the train speed was 55 mph. At 5:08:04 p.m., the trainline pressure at the head of the train was zero and the rear-end trainline pressure was 108 psi. At 5:08:05 p.m., the pressure at the rear of the train dropped 2 psi to 106 psi and remained at 106 psi for 7 seconds. At 5:08:11 p.m., the EOT went into emergency. The trainline pressure at the rear end dropped to zero at 5:08:12 p.m. At 5:08:15, the engineer activated the EOT device. (See appendix E for more detailed event recorder information.)

Survival Factors

Superliner Passenger Car Windows

Amtrak Superliner passenger railcars are fitted with exterior sidewall windows on both the lower and upper level decks. They are provided in two configurations, a nonremovable and a removable window design. The removable design is identified as an "Emergency Exit window" (pursuant to FRA requirements), from which the window panel can be extracted in an emergency. Both window designs fundamentally consist of a window glazing element fitted into a window frame. The window glazing consists of parallel, dual-pane, 1/4-inch-thick transparent monolithic polycarbonate glazing sheets, held together by an aluminum perimeter frame. There is 1/4 inch of airspace between the two glazing sheets. The window frame is kept in place by a rubber grommet fitted around the window perimeter, which is (on the outside of the railcar) somewhat round in cross section and protrudes about 1/2 inch beyond the plane of the railcar car body sidewall surface. Examination of undamaged Superliner railcars indicated that the edges of the window grommets, at the point of contact with the railcar car body sidewall panel, form a

---

[67] The Auto Train trainline was set for 110 psi.

tight fit against the railcar car body sidewall panel without any apparent gaps or voids, and the car body sidewall panels were observed to be square, true, and in plane, and without apparent warpage or other deformation.

The exterior right-side sidewall panels of Superliner railcars #32074, #32503, #33101, #38052, #32501, and #32100 exhibited denting, abrasive markings, and battering damage. They also displayed obvious rounded indentions in the roofline between the transverse structural members of the roof. Such damage, which was most prominent in Superliner railcars #32501 and #32100, was consistent with a car body sidewall and roofline that had come into contact with objects along the railroad right-of-way and/or the terrain and/or damaged trackage right-of-way (track ballast, crossties, and/or running rail) during a derailment and subsequent rollover of the railcar. Examination of the damage indicated that the sidewall and roofline elements had become severely warped and displaced from their normal configurations, in a manner consistent with the action that could have contributed to the dislocation of the window grommets and the dislodgment of the window framing structures. Small tufts of vegetation and remnants of splintered trees (severed branches and clusters of leaves) of a character similar to the trees along the perimeter of the track right-of-way were also found embedded in crevices of the mangled window frame elements of several of the damaged Superliner railcars. Remnants of dislodged and splintered trees were found along the track right-of-way near where the Superliner railcars came to rest.

Amtrak technical staff represented to Safety Board investigators that the damage sustained by the Superliner exterior sidewall window assemblies and their component elements in this accident was to a degree that was far beyond original intended design criteria. (See figure 11 for postaccident views of railcars with compromised windows.)

Four passengers assigned to deluxe bedrooms in Superliner railcar #32100 who were inside the railcar prior to the derailment were found (by emergency responders) outside the railcar after the derailment. All four sustained fatal injuries. Two passengers assigned to deluxe bedrooms in Superliner railcar #32501 who were inside the railcar prior to the derailment were found (by emergency responders) outside the railcar, one fully and one partially, after the derailment. Both persons sustained serious injuries.

Superliner Sleeper Car Folding Armchairs

The deluxe bedrooms in Amtrak Superliner sleeper cars contain a folding armchair that is not secured to the floor or other attachment point. During the derailment, several armchairs became wedged in the doorways of deluxe bedrooms in cars that were on their sides. Two passengers reported that they were injured when they were struck by armchairs or when they were thrust out of armchairs and against some hard surface.

Figure 11. Postaccident Superliner sleeper cars. Top photo shows car 32503 with damaged lower level sidewall windows and largely undamaged upper level windows. Bottom photo shows car 32100 with compromised sidewall windows on both levels.

The typical service location of the folding armchair is an open space of the deluxe bedroom, facing a sofa, in an area measuring about 4 feet by 4 feet. The armchair can be repositioned to accommodate the needs of the user or moved elsewhere in the railcar. When not needed, it can be folded and stowed, although it is usually in use during daytime operations and positioned in its normal service area. The armchair is constructed of a welded stainless steel frame structure, tubular stainless steel legs, an upholstered seat-bottom cushion, an upholstered seatback cushion, and folding upholstered armrests. The chair weighs about 55 pounds. In its open configuration, it measures about 25 inches wide by about 28 inches deep by about 25 1/2 inches high. When folded, it measures about 23 inches wide by about 25 inches deep by about 10 inches high. The folding armchair cannot be readily moved through the sliding main access door of the deluxe bedroom without first folding it. (See figure 12 showing the folding armchair.)

Figure 12. Exemplar of Superliner sleeper car folding armchair.

Investigators could find no regulatory requirements that specifically address provisions for folding armchairs in passenger railcars. Regulatory requirements addressing the category “interior fittings and surfaces,” which includes passenger railcar seating, are at 49 CFR 238.233. The regulations apply to passenger railcar equipment "ordered on or after September 8, 2000 or placed in service for the first time on or after September 9, 2002." These regulations state that "Each seat… shall be securely fastened to the car body…." All the passenger railcars involved in this accident went into service before September 8, 2000.

Amtrak technical personnel told Safety Board investigators that they have received a proposal from a firm for a device that would provide anchorage for the armchair in its unfolded and folded configurations. Amtrak expects that the device, when installed, will fulfill the safety criteria detailed at 49 CFR 238.233.

Testing and Research

Track Forces Induced by CSXT Coal Train N16815

CSXT coal train N16815 had passed over the accident curve a few minutes before the Auto Train on the day of the accident. The coal train was traveling southbound, in the opposite direction of the northbound Auto Train, when it passed through the accident location at 39 mph. The coal train was made up of 2 six-axle locomotive units and 95 loaded coal cars with a gross trailing weight of 12,950 tons. (This was about 136 tons per car or 17 tons per wheel.) The cars were equipped with conventional body-mounted brake rigging and ABDW freight brake valves.

When interviewed by Safety Board investigators, the coal train-operating crew reported the same general events, control inputs, and speeds that had been recorded in the recovered coal train event recorder data. The coal train crewmembers told investigators that the track in the accident area was not rough and that they experienced no track irregularities when they passed over it. The coal train crew recalled no abnormalities in train-handling or train slack.[68] The crewmembers said they made no emergency applications of the coal train air brakes nor did they undertake any other braking activity while passing through the accident curve.

Safety Board investigators conducted computer simulations for the CSXT coal train at the New York Air Brake (Knorr) Train Dynamic Services facility in Fort Worth, Texas, from July 15 through 18, 2002. Party representatives from Amtrak, CSXT, the FRA, and the Brotherhood of Locomotive Engineers were present. The CSXT coal train simulations were performed to determine whether the coal train had placed any excessive forces on the track in the area of the derailment prior to the passage of the Auto Train. Data from the coal train's locomotive event recorder were used, as well as information concerning the track profile and the coal train's equipment types and weights. The simulations were designed to show in-train forces. Some in-train forces are transferred to the track structure, but these simulations were not designed to show a direct relationship between the track and the in-train forces.

---

[68] *Train slack* is unrestrained free movement between the cars in a train.

The computer simulations indicated that because the coal train passed over the accident area with little change in control inputs and because the train was negotiating small changes in track curvature and grade, it imparted expected amounts of force to the track structure. No significant in-train forces were identified. Within their limitations, the simulations indicated that the coal train's passage over the accident trackage in the minutes before the derailment had placed no unusual burden on the track structure. (The routine passage of a train that imparts relatively moderate force to the track structure may trigger a track buckle if sufficient weaknesses exist in the track's structure or if there are problems with the track's maintenance.)

CWR-SAFE Program

Track buckling is a phenomenon that occurs suddenly because of track instability. The main determining factors for track buckling are the lateral track resistance, which is largely influenced by the amount of shoulder ballast and the strength of the tie-ballast bond; the longitudinal rail force, which is primarily a function of the neutral rail temperature and rail anchor condition; and the track's lateral alignment condition.

To determine if a track buckle was feasible in the accident curve under the conditions at the time of the derailment, the Safety Board asked the Volpe Center in Cambridge, Massachusetts, to perform a track buckling analysis with a computer software program called "CWR-SAFE," which had been developed for the FRA. The computer program determines the "allowable temperature increase" for buckling prevention and the buckling safety margin. CWR-SAFE also includes a program for risk-based buckling safety evaluation, with the key output being "probability of buckling versus rail temperature." The Safety Board provided Volpe with factual track information to formulate the parameters for the buckling analysis.

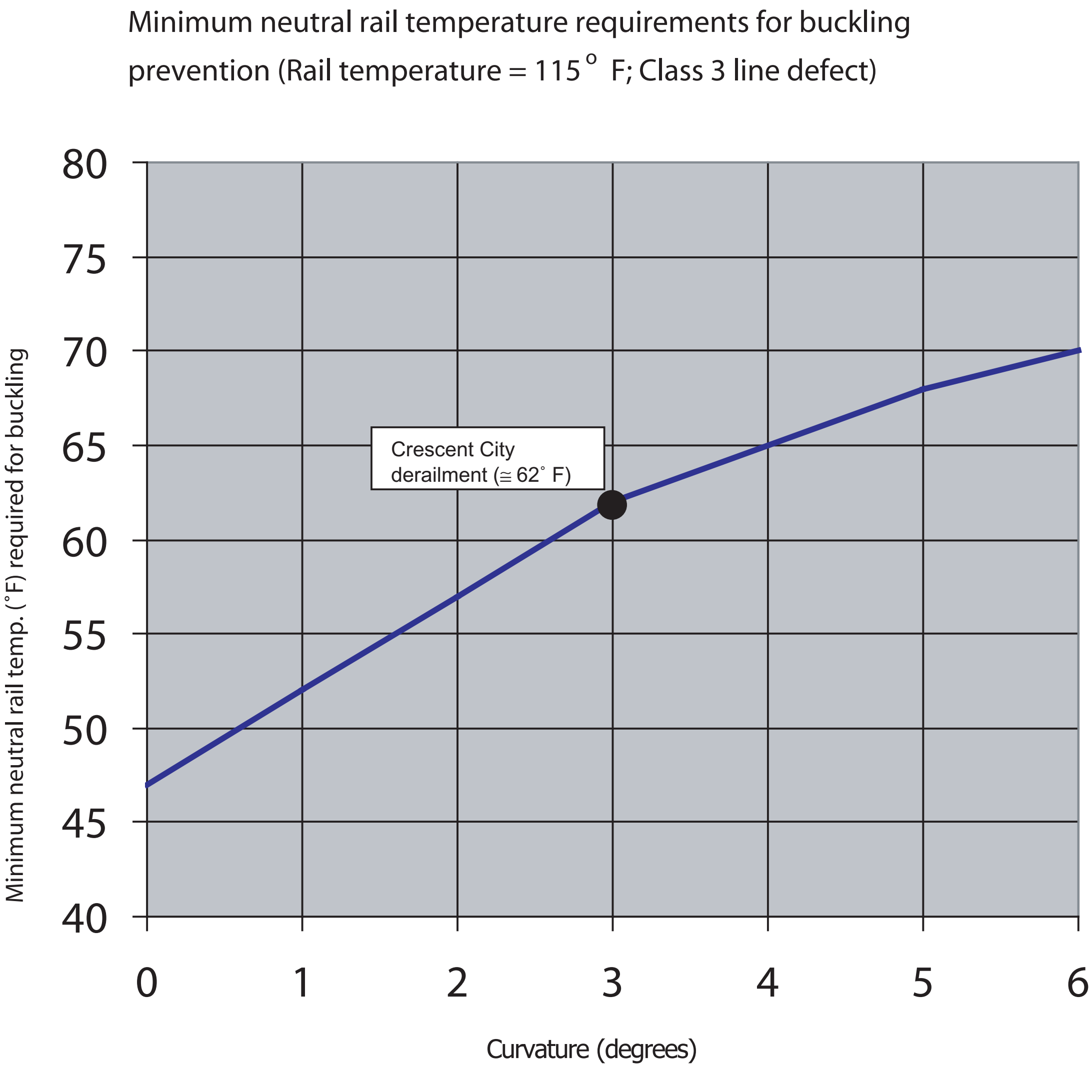
After assuming the parameters to replicate the site conditions, Volpe ran the computer model to reconstruct the neutral rail temperature that would result in a buckle. For track with wooden ties, assuming a relatively "weak" lateral resistance condition in line with the reported ballast conditions, recent surfacing, tie replacements for a 3-degree curve with Class 3 (1.75-inch) lateral alignment defects,[69] and an estimated rail temperature (ambient temperature estimate of 85° F + 30° F) of 115° F at time of derailment, the analysis indicated that if the neutral rail temperature were between 60 and 65° F, the track may be prone to buckle.

The graph in figure 13 shows the CWR-SAFE program results as a function of curvature for track with Class 3 line defects and a rail temperature of 115° F. The program indicated that the neutral rail temperature requirement for buckling was 62° F.

Analysis was also performed for different conditions and parameters. Had the actual rail temperature at the time of the derailment been higher, at 120° F, then the neutral

---

[69] Although the track in the accident area was classified as Class 4, postaccident track inspections required a reduction to Class 2; so, as an approximation, the intermediary Class 3 line defect assumption was used.



PARAMETERS:
Rail: 132 pound
Ties: wood
Tie spacing: 20 inches
Ballast: granite
Lateral resistance: 75 ppi (recently surfaced)
Tie ballast friction coefficient: 1.2
Torsional resistance: 60 in-kips/rad/in
Vertical modulus: 4000 psi
Longitudinal resistance: 200 psi
Line defect: 1.75 in. (Class 3)
Rail temperature: 115° F

Figure 13. Graph representing CWR-SAFE track buckling analysis (given a rail temperature of 115° F and Class 3 track).

rail temperature required for buckling would also have been higher by 5° F, or 67° F. Had the lateral alignment condition been "better" than the assumed Class 3, then the neutral rail temperature required for buckling would have been reduced. (For instance, had the alignment condition been Class 4, a reduction of 5° F would have resulted). Conversely, had the lateral alignment been "worse" (larger than 1.75 inch), the neutral rail temperature required for buckling would have increased. The CWR-SAFE program also showed that Class 4 accident track with a rail temperature of 120° F was similar with respect to buckling propensity to Class 3 track at 115° F.

Postaccident Developments

As a result of this derailment and a subsequent Amtrak derailment in Kensington, Maryland, the FRA conducted a "focused inspection" in August 2002 of all CSXT track on which Amtrak and commuter rail trains operate. In addition to their normal inspection activities, FRA inspectors were instructed to pay particular attention to CSXT's procedures required under 49 CFR 213.119 concerning CWR track. According to the FRA's audit report, of the 4,770 route miles inspected, 511 track miles did not conform to CSXT's standard ballast section requirements. With respect to the Sanford Subdivision, of the 212 route miles inspected, 14.6 track miles did not conform to ballast section requirements. In addition, six substandard anchor locations were found on the Sanford Subdivision. The FRA issued numerous exceptions with respect to the results of this focused inspection.

Also as a result of this accident and the subsequent Kensington derailment, CSXT provided refresher training (over and above annual training) to tamper operators and surfacing team supervisors, re-emphasized the need to submit Track Disturbance Reports, and re-emphasized the need to conduct track tamping procedures. CSXT also now requires that Track Disturbance Reports be submitted weekly rather than monthly.

On July 31, 2002, CSXT issued Technical Bulletin 005, entitled *Equipment Malfunctions During Surfacing Operations*. Among other requirements, the bulletin stated that "if a tamper malfunctions during surfacing operations in a manner that adversely affects the quality of the raising, aligning, or ballast compaction," the limits of the affected area, including the entire curve, must be checked and reworked if necessary with a fully functioning tamper machine. This technical bulletin remains in effect until replaced by a CSXT Maintenance of Way Instruction.

After the Crescent City accident, CSXT widened the track roadbed through the accident area to a width of about 30 feet. The roadbed was extended to accommodate an access road parallel to the track.

Analysis

This analysis is organized into five main sections. The "Accident" section will discuss the events that took place on the day of the accident, as well as those issues that the Safety Board was able to exclude from involvement in the accident. The second main section will address "Track Condition and Maintenance" and discuss the environment and events in the years and months preceding the accident that led to the derailment. The remaining three sections, "Derailment Dynamics," "Passenger Accountability," and "Railcar Crashworthiness," concern safety issues that developed as a result of the derailment.

Accident

Synopsis

The Auto Train derailed on April 18, 2002, in a left-hand curve near Crescent City, Florida, about 5:08 p.m., about an hour after departing its origin point at Sanford, Florida, heading northward to its destination of Lorton, Virginia. The train made no station stops from 4:08 p.m., when it departed Sanford, until the accident occurred. The train stopped and waited on the mainline at Seville, Florida, till 5:00 p.m. for a CSXT southbound coal train to pass it. About 8 minutes later, while traveling in the curve outside Crescent City, the Auto Train engineer saw a track irregularity, which he referred to as a "kink," just before the locomotive passed over it. Despite being jolted as the locomotive moved over the track irregularity, the engineer managed to initiate a service application of the train air brakes. A few seconds later, he made an emergency application of the automatic air brakes. The train derailed. The engineer activated the two-way EOT device about 15 seconds after making the emergency air brake application.

Exclusions

None of the Amtrak on-board personnel reported any significant problems or unusual events involving the equipment during the train's 1-hour preaccident journey. The engineer said that the train handled as expected, and neither he nor the assistant engineer recalled any signal or train control problems. Postaccident inspections of the Auto Train; subsequent tests of the locomotive controls, braking systems, and EOT device; and review of vehicle maintenance records did not indicate any problems with the Amtrak train equipment. Therefore, the Safety Board concludes that the Auto Train and its related equipment functioned as designed and did not cause the accident.

The investigation examined a number of Amtrak train-operating crew human performance factors that might have affected the accident. Review of the event recorder data with respect to train handling showed that before the locomotive passed over the track irregularity, the engineer handled the Auto Train in accordance with accepted practices and procedures. Postaccident drug and alcohol testing results for the train-operating crewmembers were negative. The work-rest histories of the train-operating crewmembers indicated that fatigue had no role in the accident. Therefore, the Safety Board concludes that the accident was not caused by improper train handling, drug or alcohol use, or crewmember fatigue.

Postaccident testing of the CSXT signal equipment and train control system demonstrated that they worked as designed. No communications problems were reported among the train-operating crewmembers or between the train crew and the dispatcher. Therefore, the Safety Board concludes that neither the signal equipment, the train control system, nor the communications caused or contributed to the severity of the accident.

Within 7 minutes of the accident, the first emergency responder arrived on-scene. About 12 minutes after the accident, the chief of the Crescent City Fire Department arrived on-scene and assumed incident command, but he had accidentally left his radio at the fire station. He began organizing the response but left the command post to assess the accident. The training coordinator for Putnam County Emergency Services, en route to the scene, attempted to contact the fire chief but was unable to do so because the chief had no radio with him. After he had arrived on-scene, and after several minutes of being unable to contact the fire chief, the training coordinator, as the highest-ranking emergency responder on-scene, assumed incident command about 5:46 p.m.[70] By the time the training coordinator assumed incident command, less than 40 minutes had elapsed since the accident, so this minor organizational problem did not significantly delay or impair the effectiveness of the emergency response.

The training coordinator immediately established a command post, a staging area, and a triage area. In all, 441 emergency responders responded to the accident, so there were nearly as many emergency responders as people on the train. All of the more than 400 passengers were evacuated from the train's 16 passenger cars within 2 hours of the accident. The Safety Board concludes that the overall emergency response to the accident was timely and effectively managed.

Track Buckle

The Auto Train engineer stated that as the train approached the point of the derailment, he saw that both rails ahead of the train were out of alignment. He said that the rails were parallel to one another and out of alignment to the outside of the curve by about 10 inches. When he subsequently reported the derailment to the dispatcher, he described this misalignment as "a bad kink in the rail." The term "kink" refers to the track irregularity more properly called a track buckle.

---

[70] The training coordinator was following established incident command guidelines when he assumed incident command. Because the training coordinator was the senior emergency responder on-scene, incident command authority would probably have been transferred to him under regular procedures had the fire chief been at the command post when the training coordinator arrived.

The investigation examined whether the passage of the southbound CSXT coal train N16815, shortly before the Auto Train, might have triggered the track buckle. When a railroad wheel rolls on the rail, a longitudinal wave is created in front of the wheel as the wheel slightly depresses and “pushes” the rail before it. This imparts compressive dynamic force into the rail. Track buckles may be induced or triggered by the passing of a train when the compressive dynamic forces are added to preexisting thermal forces. Once track begins to buckle out of alignment under a train, the buckle will become progressively more severe as each wheel impacts the rail.

A track buckle may occur toward the rear of a passing train, where it may or may not cause a derailment. If the train is moving slowly enough and the cars are heavy enough, the train may negotiate the buckle and continue without the train crew’s noticing it. The coal train that preceded the Auto Train over the accident curve (moving in the opposite direction) was traveling at 39 mph, which was 21 mph below the speed restriction of 60 mph. The coal train was made up of 2 six-axle locomotive units and 95 loaded coal cars, weighing about 136 tons each. Thus, the coal train was likely moving slowly enough and its cars were heavy enough that a track buckle could have developed under the coal train unnoticed by its crew.

Although a track buckle might form ahead of a train, such buckles more typically form at the rear of a passing train, due to the progressive force imparted as each car of the train moves over the susceptible area. The Auto Train engineer stated that the buckle was already in the track ahead of the Auto Train when he saw it, not that he saw it forming. Therefore, the Safety Board concludes that the track buckle that caused the derailment of the Auto Train probably originated during the passage of CSXT coal train N16815 over the accident curve.

Track Condition and Maintenance

The events that led to the development of a track buckle at this location had evolved for more than a year prior to the accident and concerned the track conditions at the accident curve, as well as the track maintenance activities that took place at and near this site. Specifically, the investigation indicated that the roadbed width of the track on the curve embankment, the ballast condition of the track, the rail anchoring in the area, the surfacing operations undertaken by CSXT at this location, and the rail temperature practices used during and after the surfacing operations all contributed to the track instability that allowed the track buckle to form. Individually, perhaps none of these factors would have generated the track buckle; in combination, they created the unstable track environment conducive to the sudden development of a buckle on April 18, 2002.

Roadbed, Ballast, and Rail Anchor Conditions

The CSXT standard engineering plan for new roadbed requires a 30-foot-wide roadbed. CSXT does not have a specific roadbed width maintenance requirement; instead, it requires roadbeds to be maintained so that they adequately support the ballast section.

Based on the known tie dimensions and CSXT track standards for existing track, Safety Board investigators calculated that the minimum roadbed width for the track on the accident curve, assuming it met the established CSXT standards, was 15 feet.[71] Visual evidence indicated that the roadbed in the accident curve was likely narrower than this minimum.[72]

The CSXT chief regional engineer for the Jacksonville District stated that the area of the derailment had a relatively narrow roadbed. He also stated that in some cases, CSXT "roadbeds become narrow because we continue to elevate the track by surfacing our track and raising the track structure." Because the roadbed in the accident curve had narrowed so that it could not adequately retain the normal ballast profile, ballast migrated down the inside slope of the embankment in the months before the accident, necessitating repeated resurfacing operations.

Despite the narrow roadbed, it appears that the ballast had not begun to migrate significantly until early in 2001. In fall 2000, about 18 months before the accident, CSXT had conducted shoulder ballast cleaning operations through the accident curve, in an effort to improve track drainage. The shoulder ballast cleaning removed fouled ballast from the shoulder area of the track, cleaned the ballast, and returned the cleaned ballast to the shoulder. However, according to the local CSXT track supervisors and inspector, in the months after the cleaning, ballast began migrating down the inside of the curve embankment. Evidently, by breaking up the hardpan soil supporting the ballast, the cleaning process had freed the ballast and allowed it to move down the inside of the curve embankment.

Adequate ballast is crucial to ensuring the track's lateral support and restraint. Because of the track's narrow roadbed and the consequent ballast migration, CSXT could not maintain sufficient ballast around the ties and rail at the roadbed track level at the top of the embankment to provide adequate support and restraint. In an attempt to halt ballast migration down the inside slope of the accident curve, CSXT constructed a ballast-retaining wall of used concrete ties on March 6, 2002, about 6 weeks before the accident occurred. The CSXT track inspector for this area acknowledged that before the installation of the ballast-retaining wall, the ballast levels supporting the track at the accident curve were not sufficient to meet CSXT standards. In particular, with respect to the shoulder ballast, he stated, "It wasn't maintained to [CSXT] standards with the 12 inches of ballast on the high side and 6 inches on the low, two-to-one."

---

[71] The ballast depth dictates the length of the 2:1 ballast shoulder slope. Because the ties were 7 inches deep and the minimum ballast depth beneath the ties was 8 inches, the ballast profile depth was 15 inches. Thus, a 2:1 ratio means the length of the ballast shoulder slope was 30 inches on each side of the track. According to CSXT standards, the inside curve ballast shoulder width should have been 6 inches and the outside curve ballast shoulder width should have been 12 inches. The length of a tie was 8 feet, 6 inches, or 102 inches. Therefore, the minimum roadbed width necessary to support the CSXT ballast shoulder profile for the accident curve was 30+6+102+12+30 inches = 180 inches, or 15 feet.

[72] Because the derailment forces largely destroyed the roadbed and track in the immediate area of the accident, investigators could not measure the roadbed at this location after the accident took place. However, investigators examined the roadbed immediately preceding and beyond the derailment site.

Safety Board investigators inspected the track adjacent to the derailment site after the April 18, 2002, accident and found that in many places the ballast did not fill the tie cribs between the crossties. Many cribs were only half full in the center and even less full toward the ends. Investigators found little or no ballast off the ends of the ties, let alone a full ballast shoulder up to the tops of the tie ends. Therefore, the Safety Board concludes there was insufficient ballast on the accident curve prior to the accident to meet CSXT's own standards and to ensure that the CWR was being adequately restrained.

In August 2002, the FRA conducted a focused inspection of all CSXT track on which Amtrak trains and commuter rail traffic operate. According to the final FRA report, of the 4,770 CSXT route miles the FRA inspected, 511 track miles did not conform to CSXT's own ballast section requirements.

Rail anchoring restricts the longitudinal movement of the rail, which localizes the compressive or expansive forces in the rail so that these forces are distributed uniformly throughout the track structure. Postaccident inspection of the undamaged track north and south of the derailment site revealed a number of locations where rail anchors were missing or where rail anchors were not snug against ties. Nineteen percent of the rail anchors required through the accident curve were determined to be missing or not snug against ties.

A rail anchor that is not snug against the tie allows longitudinal rail movement in one direction to the extent of the distance or gap between the tie and the anchor. Longitudinal rail movement may be due to thermal expansion, which is a function of rail length. The free expansion or contraction in a 3-foot length of rail with a 50° F difference in rail temperature throughout a day would be about .008 inch. (In a 1/4-mile length of rail, this would total about 3 1/2 inches.) Therefore, to adequately restrain the rail, a rail anchor must be snug against a tie, because if the gap between the tie and anchor is (as in the cited example) greater than .008 inch, theoretically, the anchor would never contact the tie or provide any restraint. Thus, a rail anchor that is not snug against a tie is unlikely to provide significant rail restraint. AREMA, rail anchor manufacturers, and industry experts agree that for rail anchors to be effective, they should be against the tie. In the rail anchor standard in its Maintenance Bulletin MWI 1113-01, *Performance for Large Scale Track Work*, CSXT states that anchors not snug against ties constitute a defect. The Safety Board concludes that missing rail anchors and ineffective rail anchoring contributed to track instability through the accident curve.

Although the FRA does not have a minimum requirement for the number of effective anchors for CWR track, CSXT has, as noted above, established its own rail anchoring standards. However, only CSXT's large system-wide track maintenance production teams are required to adhere to the anchoring standards in Maintenance Bulletin MWI 1113-01. Because CSXT does not require its local maintenance-of-way crews to use such standards, they typically rely on the experience and judgment of local supervisors, which might not be adequate to ensure a safe track condition. Therefore, the Safety Board believes that CSXT should require all track maintenance employees, including large system-wide track maintenance team members and local maintenance-of-way crew members, to use a consistent rail anchor standard that includes a requirement that rail anchors be maintained snug against ties.

Track Alignment After Surfacing

On October 9, 2001, regional CSXT surfacing gang members began to surface the full curve from MP 722.5 to MP 722.1, working from south to north. While working on the northern end of the curve and into the north curve spiral, they realized that the track liner-tamper machine they were using was not lining the track properly. By manually adjusting the machine, they were able to finish surfacing the curve. Two days later, on October 11, after the liner-tamper machine was repaired, the surfacing gang members used it to re-line and tamp the track from the point at which they estimated the machine had first experienced problems and continued north through the rest of the curve and spiral. The gang members did not record the exact location at which the liner-tamper machine went out of alignment, nor did they document the exact location at which the machine was subsequently restarted 2 days later. Therefore, the repaired liner-tamper machine may well have been started at a point in the curve beyond where the machine had actually first deviated, which would have resulted in a discontinuity in the constant smooth transition of the curve and the introduction of a slight deviation or “notch” in the curve that provided a weak point in the track.

This area of the track was repeatedly machine-surfaced in the months before the accident. On November 19, 2001, the surfacing gang machine-surfaced portions of track on the northern section of the curve. On February 26, 2002, the curve was machine-surfaced from MP 722.3 to MP 722.1; and on March 11, 2002, the curve was machine-surfaced from MP 722.3 to MP 722.2. At no time during these surfacing processes was the curve measured or checked against a reference point to ensure that the alignment was correct or that a smooth transition was maintained.

If an alignment deviation was introduced somewhere near the middle of the curve during the work on October 11, 2001, the subsequent surfacing operations would not have corrected it. The deviation would have remained a weak point in the curve alignment. Given that surfacing work is recorded to the nearest 1/10th of a mile, it is reasonable to suppose that the point of derailment, MP 722.24, fell within the weak anomaly area introduced on October 11, 2001.

Therefore, the Safety Board concludes that the problems with the liner-tamper machine on October 9, 2001, and the re-implementation of the repaired machine well into the curve on October 11 introduced a track misalignment and caused a weak point in the curve that was susceptible to later buckling. On July 31, 2002, CSXT issued Track Bulletin 005, notifying its track maintenance workers that if a liner-tamper machine broke down during a surfacing operation in a way that “adversely affected the quality of the raising, aligning or ballast compaction,” they should (among other requirements) check and, if necessary, resurface the entire curve.

CWR Temperature Control

Track buckling occurs when the difference between the current rail temperature and the neutral (force-free) rail temperature creates thermally induced internal longitudinal rail forces strong enough to overcome the track's lateral restraint. These thermally induced forces will accumulate at the weakest point in the track, which will create a track buckle when the lateral restraint is overcome.

To determine what conditions led to the development of the track buckle at the Crescent City curve, it was necessary to establish the current rail temperature when the track buckle developed. Although no one measured the rail temperature at the accident curve around 5:00 p.m. on April 18, 2002, when the track buckle likely developed, meteorological reports indicate that the ambient temperature about that time was in the low 80s (° F), and the day was mostly sunny. When the rail temperature was measured 2 days after the accident, during the late afternoon of April 20 (a partly sunny day), the rail temperature at the accident site area was 120° F at a time when the ambient temperature was in the high 80s (° F). On April 24 (a partly sunny day) at 5:00 p.m., the ambient temperature was 83° F, and the rail temperature was 108° F. Given that the ambient temperature on April 18 was similar to that on April 24, a neutral rail temperature of at least 108° F seems likely. In addition, April 18 was a mostly sunny day while April 24 was only partly sunny. The cumulative effect of hours of nearly continuous sunshine on metal rail by late afternoon on the day of the accident likely increased the rail temperature by a further significant increment. Therefore, it seems probable that the rail temperature about 5:00 p.m. on the day of the accident was well above 108° F. A current rail temperature of between 110° and 120° F is entirely feasible.

The CWR-SAFE computer program, which determines the "allowable temperature increase" for buckling prevention and the buckling safety margin, indicated that CWR may buckle when the difference between the neutral rail temperature and the current rail temperature is 50° F or more, depending on the condition of the ballast and track structure.[73] For the Crescent City accident curve, the CWR-SAFE program predicted a neutral rail temperature for buckling of between 60° and 65° F.

Given a neutral rail temperature of 60° to 65° F and an increase in rail temperature of 50° F, the resulting current rail temperature of around 115° F on the afternoon of the accident could have resulted in a track buckle. Consequently, investigators attempted to determine how a neutral rail temperature in the 60° to 65° F range might have developed for the rail in the accident curve.

Numerous maintenance operations were performed in the accident area in the 6 months before the derailment. The repeated surfacing operations have already been noted. These maintenance operations were carried out in the cooler months of the year, when rail temperatures were well below the CSXT neutral rail temperature standard of 100° F. No rail adjustments were performed after these maintenance operations broke the

---

[73] The better the track structure, the greater the difference in temperature the track can withstand. Conversely, the weaker the track structure (particularly if it is deficient in ballast), the less rail temperature change the track can withstand before buckling.

bond between the ballast and the ties. (Under these conditions, appropriate rail adjustment according to CSXT procedures would have consisted either of removing the rail anchors, heating the rail, and then reanchoring it, or of realigning the curve.)

Proper rail temperature control is critical during the period immediately after the track has been disturbed and until the track is reestablished and firmly stabilized in the ballast. On February 26, 2002 (about 7 weeks before the accident), the CSXT regional surfacing gang machine-surfaced the track segment from MP 722.3 through MP 722.1, which encompassed the point of derailment (MP 722.24). The rail temperature was measured at 90° F when the work was completed on February 26.

After this surfacing, the ambient temperature in the area decreased for the next 3 days while the track was in the post-surfacing stabilization process. The following were the daily high and low ambient temperatures from February 26 through March 1:

February 26	75° F	45° F
February 27	68° F	36° F
February 28	55° F	36° F
March 1	66° F	48° F

The track was exposed to a range of relatively low temperatures during the 3-day period following the February 26 surfacing, while the track was most subject to movement.[74] Temperatures during this period were in the 60s (° F) and lower, making the CWR-SAFE criteria of a 60° to 65° F neutral rail temperature not only feasible but probable.

Adequate ballast could have helped to restrain, if not prevent, the rail from significantly contracting. Given the lack of ballast, which would have allowed the track to move with relative ease, the rail could have contracted to a low neutral rail temperature, causing the curve to "chord" (shrink) inward, which would have made it prone to buckle when the weather warmed. When about 70 tons of ballast was dumped on the north end of the accident curve on March 8, the rail had already had ample time (10 days) to contract to a new and lower neutral rail temperature without sufficient ballast restraint. Because the track in the curve did not have sufficient ballast, it was inadequately restrained after being disturbed on February 26. CSXT and industry maintenance practices for surfacing CWR track recommend that track not be surfaced until sufficient ballast is distributed to provide the necessary restraint. Insufficient restraint, caused by insufficient ballast, will permit the track to move during stabilization or possibly not to stabilize at all. A later application of ballast, such as CSXT's addition of 70 tons of ballast to the curve on March 8, will not correct this problem, because movement may have already occurred. Therefore, the Safety Board concludes that the accident curve chorded inward because there was insufficient

---

[74] A slow order was in effect for MP 722.3 though MP 722.1 from February 5 through March 13, 2002.

ballast in the track at the time of the February 26, 2002, surfacing to prevent track movement as the track stabilized.

On March 11, the accident curve was resurfaced, this time between MP 722.3 and MP 722.2, a segment containing the point of derailment. The liner-tamper machine started in the body of the curve and moved northward to create a 1-inch lift. The high and low daily temperatures in the days after this surfacing were as follows:

March 11	74° F	53° F
March 12	84° F	56° F
March 13	79° F	54° F
March 14	78° F	54° F

These ambient temperatures were somewhat higher than those in effect during the February 26 through March 1 period but were still well below those needed to achieve the desired neutral rail temperature standard of 100° F. Although less likely than the track disturbed during February 26 to fall to the 60° to 65° F neutral rail temperature range necessary for buckling, the track involved in this surfacing would still have developed significant compressive forces that would tend to further stress a buckle-prone weak point in the curve.

As has been stated, with the decline in ambient temperature that occurred after the February 26 surfacing operation (coupled with the lack of ballast on the curve from February 26 until March 8), the rail contracted and the track chorded inward. To detect track movement, CSXT requires curves over 1 degree in CWR track to be monumented if the temperature falls below 50° F during surfacing. However, CSXT procedures do not require monumenting if the temperature falls below 50° F during the stabilization period following surfacing work. (Monumenting consists of establishing known reference points against which any subsequent movement of the track can be measured.)

The temperature during the February 26 surfacing work was well above 50° F, so the track was not monumented. During the post-surfacing stabilization period, however, temperatures fell below 50° F. When the track was resurfaced on March 11, there was no way to determine whether the track had moved since the February 26 work, because the track had not been monumented on February 26. Therefore, the Safety Board concludes that because the curve was not monumented when it was surfaced on February 26, 2002, the crew resurfacing the track on March 11, 2002, did not know whether the track had moved since February 26, 2002. Had the crew members known the track had moved, they could have adjusted the curve appropriately. Therefore, the Safety Board believes that CSXT should modify its procedures to ensure that when a curve is surfaced, it is also monumented, if local temperatures are predicted to fall below 50° F during the post-surfacing stabilization period.

According to CSXT rules, each time the track is disturbed, a Track Disturbance Report is to be filled out and submitted for later rail temperature reference. At the time of the accident, CSXT required that Track Disturbance Reports be submitted monthly. (Since the accident, CSXT has required that Track Disturbance Reports be submitted weekly.) Roadmasters use the reports to identify areas that need additional attention, particularly when the weather gets warmer. The reports are also used to direct follow-up track adjustment. The CSXT regional surfacing gang foreman, who had performed most of the surfacing operations through the accident curve, admitted that on several occasions he had not submitted the required monthly Track Disturbance Reports after disturbing the track. Consequently, no timely record was available to the roadmaster indicating the necessity of performing appropriate track adjustments following the track disturbances. Also, despite the fact that regional engineering personnel were aware of the surfacing gang foreman's assignments and locations, no one from CSXT ever checked to ensure that the disturbance reports were submitted after the surfacing was done.

According to the roadmaster, local maintenance crews usually start adjusting rail that has been disturbed during the winter season when the ambient temperature rises to approach the upper 80s (° F), which in the Crescent City area typically occurs in April. The temperature on April 18, 2002, reached the low 80s (° F), and temperatures in the mid to high 80s (° F) were experienced in the days after the accident. Thus, when the accident occurred, area temperatures were nearing the range at which track adjustments were normally carried out. Therefore, the Safety Board concludes that had the Track Disturbance Reports been submitted in a timely fashion, the roadmaster might have used them to prioritize the track adjustment work to be carried out on track disturbed during the winter, including the accident curve.

In summary, regarding CSXT track maintenance, the Safety Board notes that the Crescent City investigation showed that the CSXT program was inadequate in two general respects. First, CSXT failed to establish some needed track standards. Second, CSXT failed to ensure that its track maintenance workers routinely fulfilled the requirements of its existing track standards.

With reference to the former problem, CSXT did not have adequate requirements at the time of the accident for ensuring effective rail anchoring, for monumenting curves when temperatures were expected to fall below 50° F during the track stabilization period following surfacing, or for relining the entire curve if the liner-tamper machine broke down during a surfacing operation. CSXT has since addressed the liner-tamper machine procedure deficiency, and the Safety Board has proposed safety recommendations to provide appropriate requirements for rail anchoring and monumenting.

However, the provision of new written requirements in these areas will not solve the underlying quality control problem concerning CSXT track maintenance indicated by this investigation. The Safety Board found that although CSXT had written standards for ensuring the maintenance of an adequate ballast section to restrain the track and for conducting surfacing operations according to established practices and rules (such as drafting and submitting Track Disturbance Reports at specified intervals), CSXT track employees sometimes did not fulfill these requirements. Given these deficiencies, it appears that CSXT did not have an effective quality control program that ensured strict adherence to written track standards among its track maintenance employees. Therefore, the Safety Board concludes that CSXT did not provide adequate oversight to ensure that its track maintenance activities were carried out in accordance with its own standards.

In addition, when the FRA conducted an August 2002 focused inspection of CSXT track used by Amtrak and commuter rail trains, FRA inspectors found numerous instances of track conditions that did not conform to CSXT requirements. The FRA findings, coupled with the repeated failures by CSXT track personnel to fulfill established CSXT track standards and practices revealed during this accident investigation, suggest that CSXT may have a quality control problem with its track maintenance operations, particularly in the area of track surfacing. Therefore, the Safety Board believes that CSXT should develop a systematic quality control program to ensure that track-surfacing personnel consistently conduct track-surfacing operations in accordance with CSXT standards.

Derailment Dynamics

Auto Train Consist

The first 16 cars in the train were Amtrak Superliner passenger cars; 24 autorack cars followed them. After the derailment, the two locomotive units and the first two passenger cars remained on the rails. However, the remaining 14 passenger cars and 7 of the autorack cars derailed. The 7 derailed autorack cars remained generally in-line. The other 17 autorack cars stayed on the rails. The disposition of the derailed cars, particularly the passenger cars, reflected the accordion effect of railcars when they derail, alternately folding together in parallel fashion, perpendicular to the track. The rapid and violent movements, including the laying over of some of the passenger cars, involved the dissipation of such large forces in such a relatively short distance that they probably caused the majority of the injuries and fatalities.

Traditionally, passenger trains are configured with unoccupied nonrevenue cars (such as express and baggage cars) up front and closest to the locomotive, so that these unoccupied cars will absorb the impact and forces of a collision and/or derailment. The Auto Train, however, is a unique type of passenger train, and its consist is set in accordance with the attributes of its special cars.

When trains are made up, it is generally desirable to place the heaviest cars in the front, behind the locomotive units, and the rest of the cars in descending order by weight. This type of consist is advantageous because it minimizes the in-train forces during movement, starting, and stopping, and especially during emergency braking. Superliner cars typically weigh between 150,000 and 160,000 pounds (passengers and baggage generally add no more than 5 percent to the car weight). Eighteen of the 24 autorack cars on the train were bi-level autocarriers, weighing about 122,000 pounds each, loaded, and 6 were tri-level autocarriers, weighing about 164,000 pounds each, loaded. Thus, most

(75 percent) of the autorack cars in this consist were about 30,000 pounds lighter than the Superliner cars, and even the six tri-level autocarriers were only slightly heavier than the Superliner cars. Consequently, from a train density standpoint, the on-average heavier Superliner cars were optimally located near the front of the Auto Train consist.[75]

Two-Way End-Of-Train Device Activation

According to locomotive event recorder information, it was not until about 10 seconds after the engineer put the train in emergency (at 5:08:01 p.m.) and about 7 seconds after the air brakes went into emergency (at 5:08:04 p.m.) that the emergency braking signal actually reached the rear of the train (at 5:08:11 p.m.). There were likely two reasons for this time gap; a pinched trainline air hose between cars and the engineer's delay in activating the two-way EOT device to initiate an emergency brake application at the rear end.

Investigators deduced that a pinched trainline air hose between cars kept the pneumatic signal from reaching the rear of the train when the air brakes went into emergency at the head end. About 7 seconds later, the derailment forces caused a break in the trainline air hose beyond the pinched area, which caused the remainder of the train to go into emergency. The engineer did not activate the EOT device until 5:08:15 p.m., about 15 seconds after he had put the train into emergency. By that time, the EOT device activation was unnecessary, because the full train was already in emergency due to the break in the trainline.

Had the engineer immediately activated the two-way EOT device when he put the air brakes in emergency, the rear of the train would have gone into emergency with the head end, which would have minimized car movement. The 7-second delay between the train's air brakes going into emergency and the emergency signal reaching the end of the train allowed the cars at the rear of the train to continue to move into the forward cars, which were braked and/or stopping.

The delay would have been avoided if the two-way EOT device had been automatically activated at the same moment the engineer put the train's air brakes in emergency. The Safety Board has previously discussed the benefits of automatic activation of EOT devices on trains. In the Bloomington, Maryland, freight train accident report,[76] the Safety Board noted that CSXT had installed automatic two-way EOT devices on all its new locomotives. However, this was not the case. CSXT had actually installed automatic-*ready* two-way EOT devices, which could not, when installed, effect the simultaneous, automatic application of the brakes at the end of the train with the engineer's emergency application of the brakes. To function properly, the installed devices

---

[75] In addition, the passenger cars on the Auto Train, which require electrical power from the locomotive units, are placed nearest the locomotives to minimize electricity transmission distance and connections. The autorack cars do not have conduits and piping because they do not require electricity, and because they are typically placed on the end of the train, there is no need to transmit electrical power to or through them.

[76] National Transportation Safety Board, *Derailment of CSX Transportation Coal Train V986-26 at Bloomington, Maryland, January 30, 2000*, Railroad Accident Report NTSB/RAR-02/02 (Washington, DC: NTSB, 2002).

need the additional installation of a computer card encoded with the necessary information technology (software). This technology was not yet available when CSXT installed the devices nor at the time of the Crescent City derailment. Since the Crescent City accident, however, automatic two-way EOT application technology (as provided through the encoded computer cards) has reached the final development stage and should soon be ready for use.

The Safety Board concludes that had the two-way EOT device been activated when the Auto Train's air brakes were put in emergency, the severity of the injuries resulting from the derailment might have been lessened, because the continued forward momentum of the majority of the train's cars into the stopped passenger cars would have been reduced. At the time of the accident, Amtrak locomotives were not equipped with automatic two-way EOT devices. Consequently, the Safety Board believes that Amtrak should install automatic two-way EOT emergency activation devices on all Amtrak locomotives equipped with manual devices.

Passenger Accountability

The accident Auto Train was an all-reserved passenger train that was to travel nonstop between Sanford, Florida, and Lorton, Virginia. To account for the Auto Train passengers, Amtrak was using the paper on-board record system described in its *Service Standards Manual for Management Employees* (refer to appendix B for detailed procedures). Given that the train made no scheduled stops for passengers, if this had been a reliable system, Amtrak should have been able to determine soon after the train departed from Sanford exactly how many passengers were on board the Auto Train by using the passenger manifest and the contents of the conductor's ticket collections pouch. Even though the accident occurred only about an hour after the train departed from Sanford, this still should have been sufficient time to develop a comprehensive list. Nevertheless, the incident commander told investigators that he had difficulty obtaining accurate information from Amtrak about the number of people on board the train.

When he arrived on the scene on April 18, the incident commander was told that 468 people were on the train. Subsequently, he was provided with both a greeter list and a passenger list, but the information on the two lists did not match. The incident commander later complained that emergency responders had to spend time attempting to verify the accuracy of the two lists. The day after the accident, Amtrak gave the incident commander a computer printout list, which contained information that did not match either of the two lists provided on April 18. In fact, Amtrak never provided the incident commander an accurate count of the persons on board the train. Even during postaccident interviews, long after the initial emergency response, Amtrak was still erroneously reporting the total number of people on board the train as 468.

Using information gathered and correlated from three sources—Amtrak, Putnam County Emergency Services, and medical records—it took Safety Board investigators almost 5 months to determine the number of Auto Train occupants at the time of the accident. The total number of people on board the train was 446, a discrepancy of 22 from the figure of 468 people that Amtrak gave in the immediate response phase.

In a derailment, the survival of passengers and crewmembers might well depend on emergency responders, who in turn depend on a complete and accurate accounting of all people on the train to ensure that they locate, evacuate, and treat (if necessary) all those on board. If the passenger list does not include every passenger on the train, emergency responders may leave passengers behind. If the passenger list includes people not on the train, emergency responders may be needlessly exposed to prolonged risks as they search for nonexistent passengers. To facilitate an effective emergency response, the incident commander must have an accurate passenger list as soon as possible.

This is not the first time the Safety Board has identified passenger accountability as an issue in an Amtrak accident. Following the September 1993 Amtrak accident in Mobile, Alabama,[77] in September 1994, the Safety Board recommended that Amtrak:

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

Amtrak responded to the recommendation with a plan to develop a satellite and long-distance messaging system between long-distance trains and corporate offices. One benefit of this proposed new communications system was to be improved passenger manifests. However, following a 1997 Amtrak accident in Kingman, Arizona,[78] Amtrak told the Safety Board that passenger manifests were unrealistic on unreserved trains, due to the number of station stops such trains make. Amtrak indicated, however, that computer systems could provide passenger lists for reserved trains. As a result of this new information, the Safety Board closed Safety Recommendation R-94-7 (Reconsidered) on August 31, 1998, and issued a new recommendation urging Amtrak to:

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

---

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

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

On September 14, 1999, the president of Amtrak Intercity testified during the Safety Board's public hearing on the Bourbonnais, Illinois, accident[79] that Amtrak had made an investment of $24 million and contracted with Motorola to develop an automated system for accounting for train passengers. He described the system as a simple hand-held device to be used by the conductor, which would scan the tickets and record a passenger name. There was to be a central processing unit on the train for downloading information from the hand-held device. This information was to be transmitted to the Amtrak national reservation system and made available to a number of locations. As such, the passenger data would be readily available to emergency responders. The Amtrak official said the system was scheduled for implementation in 2000.

Because Amtrak had indicated that an automated passenger accountability system was in imminent development, the Safety Board classified Safety Recommendation R-98-58 "Closed--Acceptable Action" on December 5, 2000. However, Amtrak has not implemented such an accountability system. Since Safety Recommendation R-98-58 was closed, Amtrak has failed to provide a timely and accurate passenger count to emergency responders during at least four Amtrak accidents (including this one).[80] Earlier this year, an Amtrak official stated in a letter[81] to a Safety Board staff member:

> While Amtrak continues to explore realistic technological alternatives to enhance the efficiency of recording ticketed and non-ticketed passengers, we feel that the passenger accountability system presently in place is a reliable one.

Therefore, Amtrak still uses, and appears likely to continue to use, the paper on-board record system outlined in its *Service Standards Manual for Management Employees* to account for passengers on its long-distance, overnight, and reserved trains. However, as the Crescent City accident indicated, this system is prone to error, delay, and confusion. The system could not provide an accurate list months after the accident, much less during the crucial emergency response period. Therefore, the Safety Board concludes that the paper record passenger accountability system in use for long-distance, overnight, and reserved trains on the Amtrak system cannot be relied upon to provide an accurate and timely passenger manifest in case of emergency.

Amtrak uses the same paper record system that performed so poorly on the Auto Train for all its long-distance, overnight, and reserved trains. Amtrak operates the following trains that fall into one or more of these categories:

---

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

[80] The other three accidents took place in Syracuse, New York, in February 2001; Nodaway, Iowa, in March 2001; and Kensington, Maryland, in July 2002.

[81] Letter dated March 14, 2003, from Amtrak Chief Transportation Officer, Operations Standards and Compliance, to Safety Board investigator concerning the July 29, 2002, Amtrak Train 30 derailment in Kensington, Maryland.

Sunset Limited
Southwest Chief
California Zephyr
Empire Builder
Coast Starlight
Crescent
Texas Eagle
Capitol Limited
Three Rivers
Lake Shore Limited
Cardinal
Auto Train
City of New Orleans
Silver Palm
Silver Star
Silver Meteor
Acela Express
Metroliner
Empire Service

Since issuing Safety Recommendation R-94-7 nearly 9 years ago, the Safety Board has investigated nine accidents involving Amtrak trains from this list in which passenger accounting has been less than satisfactory during the emergency response. As has been noted, the Safety Board has repeatedly made recommendations to Amtrak concerning this issue, and Safety Board staff members have met with Amtrak representatives both formally and informally to resolve this longstanding problem. To date, Amtrak has not taken effective action to address this safety issue. Consequently, the Safety Board believes that Amtrak should develop and implement an accurate passenger and crew accountability system for all its long-distance, overnight, and reserved trains that will immediately provide an accurate count of the people on board the train in case of emergency.

In addition to facilitating effective occupant evacuation and treatment during an emergency, having more complete information about those on board a train could benefit U.S. rail transportation in other ways. An accurate listing of all people on board a train that includes information concerning the identity of each person would be useful for purposes of security as well as safety. To ensure that a passenger and crew identification system meets all safety and security needs, the two Federal agencies primarily responsible for railroad safety and security should collaborate in its creation. Therefore, the Safety Board believes that the Federal Railroad Administration and the Transportation Security Administration should, in cooperation, develop and implement an accurate passenger and crew accountability system for all long-distance, overnight, and reserved passenger trains that will immediately provide an accurate count and identity of the people on board the train in case of emergency at any time during the trip.

Railcar Crashworthiness

Superliner Passenger Car Windows

The investigation examined the construction, intended design criteria, and performance expectations of the Superliner railcar sidewall window when operating in its normal performance environment. The means of retention of those windows, which principally relies on a window grommet to keep the window assembly in place within the car body sidewall opening, was also evaluated. The investigation identified evidentiary artifacts, consisting of obvious rounded indentions in the roofline edge (between the transverse structural members of the railcar roof), small tufts of vegetation and remnants of splintered trees found within and adhering to crevices in the car body, and battering damage on the railcar sidewall panels, all of which were consistent with the extensive damage that resulted from the substantial, and somewhat prolonged, severely abrasive action of the trees along the perimeter of the trackage right-of-way in this area. Further, the residue track ballast and soil found within the railcars was consistent with the railcars having been overturned and dragged along the trackage right-of-way for some distance.

Therefore, the catastrophic breaches of the Superliner exterior sidewall windows in this accident resulted from the severe abrasive action of the trees along the track that came into contact with the exterior sidewalls of the railcars during the derailment, which resulted in the sidewall and roofline elements of the railcar becoming severely warped and displaced from their normal configurations. The abrasive contact of the trees against the sidewall windows also dislocated the window grommets (which keep the window assemblies in place within the car body sidewall openings) and subsequently dislodged the framing structures of the sidewall windows. With no means of retention, the loosened windows were unable to resist the force of the passengers who were thrust against the windows during the vehicle dynamics of the derailment, which resulted in the passengers falling out through the car body sidewall openings as the railcars overturned. Four passengers of Superliner sleeper car #32100 who were ejected through breached windows received fatal crushing injuries, and two passengers of Superliner sleeper car #32501 who were ejected (one fully and one partially) through breached windows were seriously injured.

Accordingly, given the design configuration of the Superliner railcar exterior sidewall windows, the operational history of the equipment, the vehicle dynamics of the derailment, the evidentiary artifacts examined, and the severe damage sustained by the windows (as described), the damage sustained by the windows and their component elements in this accident far exceeded the original intended design criteria and expectations.

Superliner Sleeper Car Folding Armchairs

As currently configured, each deluxe bedroom in an Amtrak Superliner sleeper car contains an unsecured folding armchair. Two Auto Train passengers reported that they were injured during the derailment when they were struck by such armchairs or when they were thrust out of the armchairs, indicating that the unsecured armchairs pose an occupant injury hazard during a derailment.

FRA regulations state, at 49 CFR 238.233, that passenger railcar seating fixtures “ordered on or after September 8, 2000, or placed in service for the first time on or after September 9, 2002,” must be securely fastened to the car body. Anchoring occupant seating substantially reduces the risk of occupants being injured by the seating in a derailment. However, because the Amtrak Superliner cars involved in this accident were put in service before September 8, 2000, the FRA requirements concerning seating anchoring are not applicable to them. Although Amtrak has indicated that it is pursuing an equipment remedy, some Amtrak trains currently travel with unsecured folding armchairs on Superliner sleeper cars. The Safety Board concludes that in its present unsecured configuration, the folding armchair on Amtrak's Superliner sleeper cars constitutes an unwarranted hazard. Therefore, the Safety Board believes that Amtrak should, within 1 year, install restraint systems for the unsecured folding armchairs in all its in-service Superliner sleeper cars. The restraint systems should meet the safety criteria established at 49 CFR 238.233.

Conclusions

Findings

1. The Auto Train and its related equipment functioned as designed and did not cause the accident.

2. The accident was not caused by improper train handling, drug or alcohol use, or crewmember fatigue.

3. Neither the signal equipment, the train control system, nor the communications caused or contributed to the severity of the accident.

4. The overall emergency response to the accident was timely and effectively managed.

5. The track buckle that caused the derailment of the Auto Train probably originated during the passage of CSX Transportation coal train N16815 over the accident curve.

6. There was insufficient ballast on the accident curve prior to the accident to meet CSX Transportation's own standards and to ensure that the continuous welded rail was being adequately restrained.

7. Missing rail anchors and ineffective rail anchoring contributed to track instability through the accident curve.

8. The problems with the liner-tamper machine on October 9, 2001, and the re-implementation of the repaired machine well into the curve on October 11 introduced a track misalignment and caused a weak point in the curve that was susceptible to later buckling.

9. The accident curve chorded inward because there was insufficient ballast in the track at the time of the February 26, 2002, surfacing to prevent track movement as the track stabilized.

10. Because the curve was not monumented when it was surfaced on February 26, 2002, the crew resurfacing the track on March 11, 2002, did not know whether the track had moved since February 26, 2002.

11. Had the Track Disturbance Reports been submitted in a timely fashion, the roadmaster might have used them to prioritize the track adjustment work to be carried out on track disturbed during the winter, including the accident curve.

12. CSX Transportation did not provide adequate oversight to ensure that its track maintenance activities were carried out in accordance with its own standards.

13. Had the two-way end-of-train device been activated when the Auto Train's air brakes were put in emergency, the severity of the injuries resulting from the derailment might have been lessened, because the continued forward momentum of the majority of the train's cars into the stopped passenger cars would have been reduced.

14. The paper record passenger accountability system in use for long-distance, overnight, and reserved trains on the Amtrak system cannot be relied upon to provide an accurate and timely passenger manifest in case of emergency.

15. In its present unsecured configuration, the folding armchair on Amtrak's Superliner sleeper cars constitutes an unwarranted hazard.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the April 18, 2002, derailment of Amtrak Auto Train P052-18 near Crescent City, Florida, was a heat-induced track buckle that developed because of inadequate CSX Transportation track-surfacing operations, including misalignment of the curve, insufficient track restraint, and failure to reestablish an appropriate neutral rail temperature.

Recommendations

As a result of its investigation of the April 18, 2002, Crescent City derailment accident, the National Transportation Safety Board makes the following safety recommendations:

To CSX Transportation, Inc.:

> Require all track maintenance employees, including large system-wide track maintenance team members and local maintenance-of-way crew members, to use a consistent rail anchor standard that includes a requirement that rail anchors be maintained snug against ties. (R-03-06)
>
> Modify your procedures to ensure that when a curve is surfaced, it is also monumented, if local temperatures are predicted to fall below 50° F during the post-surfacing stabilization period. (R-03-07)
>
> Develop a systematic quality control program to ensure that track-surfacing personnel consistently conduct track-surfacing operations in accordance with CSX Transportation standards. (R-03-08)

To the National Railroad Passenger Corporation (Amtrak):

> Install automatic two-way end-of-train emergency activation devices on all Amtrak locomotives equipped with manual devices. (R-03-09)
>
> Develop and implement an accurate passenger and crew accountability system for all Amtrak long-distance, overnight, and reserved trains that will immediately provide an accurate count of the people on board the train in case of emergency. (R-03-10)
>
> Within 1 year, install restraint systems for the unsecured folding armchairs in all your in-service Superliner sleeper cars. The restraint systems should meet the safety criteria established at 49 *Code of Federal Regulations* 238.233. (R-03-11)

To the Federal Railroad Administration:

> In cooperation with the Transportation Security Administration, develop and implement an accurate passenger and crew accountability system for all long-distance, overnight, and reserved passenger trains that will immediately provide an accurate count and identity of the people on board the train in case of emergency at any time during the trip. (R-03-12)

To the Transportation Security Administration:

> In cooperation with the Federal Railroad Administration, develop and implement an accurate passenger and crew accountability system for all long-distance, overnight, and reserved passenger trains that will immediately provide an accurate count and identity of the people on board the train in case of emergency at any time during the trip. (R-03-13)

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: August 5, 2003

Appendix A

Investigation

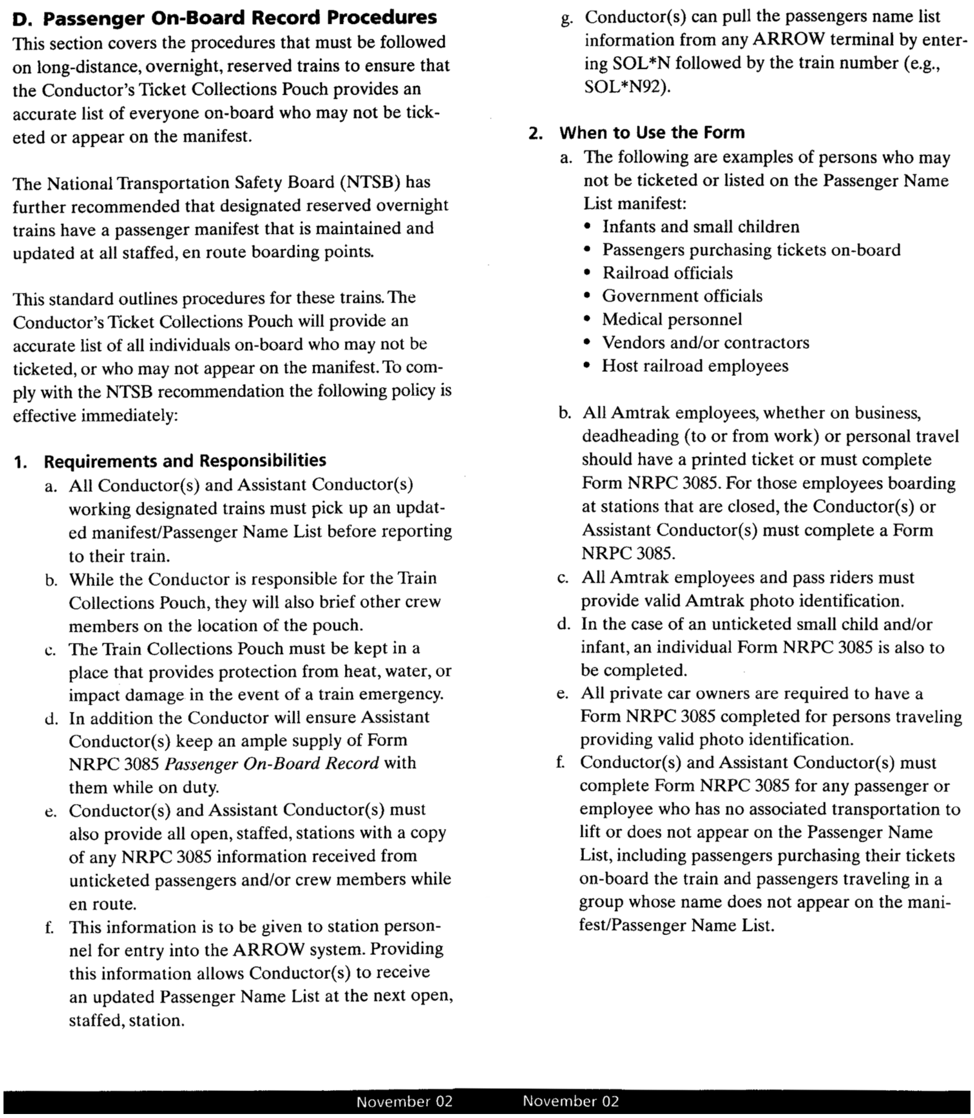
The Safety Board was notified at 5:35 p.m. eastern daylight time on April 18, 2002, that an Amtrak Auto Train had derailed near Crescent City, Florida. The Board launched a railroad accident investigation team to the site. The team included a Board Member (accompanied by a public affairs representative and two family affairs representatives) and investigative groups for operations, track, signals, mechanical, human performance, survival factors, and crashworthiness factors.

Parties to the investigation included the Federal Railroad Administration; the Florida Department of Transportation; Putnam County, Florida; CSX Transportation; Amtrak; the American Railway Engineering and Maintenance-of-Way Association; the Brotherhood of Locomotive Engineers; the Brotherhood of Maintenance of Way Employes; and the United Transportation Union.

The Safety Board held 2 days of sworn interviews as part of its investigation. The first interviews were held at Palatka, Florida, on April 22, 2002, and more were held at Jacksonville, Florida, on July 24, 2002. Parties to the interviews were the Federal Railroad Administration, the Florida Department of Transportation, CSX Transportation, Amtrak, the Brotherhood of Maintenance of Way Employes, and the Brotherhood of Locomotive Engineers. Twelve witnesses were interviewed in Palatka and 11 in Jacksonville.

Appendix B

Passenger On-Board Record Procedures from Amtrak *Service Standards Manual for Management Employees*



D. Passenger On-Board Record Procedures

This section covers the procedures that must be followed on long-distance, overnight, reserved trains to ensure that the Conductor's Ticket Collections Pouch provides an accurate list of everyone on-board who may not be ticketed or appear on the manifest.

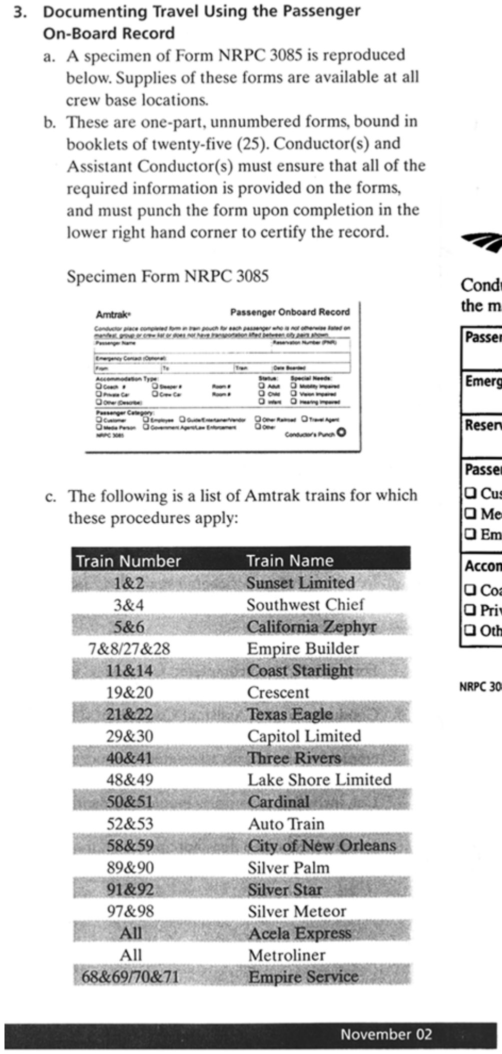
The National Transportation Safety Board (NTSB) has further recommended that designated reserved overnight trains have a passenger manifest that is maintained and updated at all staffed, en route boarding points.

This standard outlines procedures for these trains. The Conductor's Ticket Collections Pouch will provide an accurate list of all individuals on-board who may not be ticketed, or who may not appear on the manifest. To comply with the NTSB recommendation the following policy is effective immediately:

1. **Requirements and Responsibilities**
   a. All Conductor(s) and Assistant Conductor(s) working designated trains must pick up an updated manifest/Passenger Name List before reporting to their train.
   b. While the Conductor is responsible for the Train Collections Pouch, they will also brief other crew members on the location of the pouch.
   c. The Train Collections Pouch must be kept in a place that provides protection from heat, water, or impact damage in the event of a train emergency.
   d. In addition the Conductor will ensure Assistant Conductor(s) keep an ample supply of Form NRPC 3085 *Passenger On-Board Record* with them while on duty.
   e. Conductor(s) and Assistant Conductor(s) must also provide all open, staffed, stations with a copy of any NRPC 3085 information received from unticketed passengers and/or crew members while en route.
   f. This information is to be given to station personnel for entry into the ARROW system. Providing this information allows Conductor(s) to receive an updated Passenger Name List at the next open, staffed, station.
   g. Conductor(s) can pull the passengers name list information from any ARROW terminal by entering SOL*N followed by the train number (e.g., SOL*N92).

2. **When to Use the Form**
   a. The following are examples of persons who may not be ticketed or listed on the Passenger Name List manifest:
      - Infants and small children
      - Passengers purchasing tickets on-board
      - Railroad officials
      - Government officials
      - Medical personnel
      - Vendors and/or contractors
      - Host railroad employees

   b. All Amtrak employees, whether on business, deadheading (to or from work) or personal travel should have a printed ticket or must complete Form NRPC 3085. For those employees boarding at stations that are closed, the Conductor(s) or Assistant Conductor(s) must complete a Form NRPC 3085.
   c. All Amtrak employees and pass riders must provide valid Amtrak photo identification.
   d. In the case of an unticketed small child and/or infant, an individual Form NRPC 3085 is also to be completed.
   e. All private car owners are required to have a Form NRPC 3085 completed for persons traveling providing valid photo identification.
   f. Conductor(s) and Assistant Conductor(s) must complete Form NRPC 3085 for any passenger or employee who has no associated transportation to lift or does not appear on the Passenger Name List, including passengers purchasing their tickets on-board the train and passengers traveling in a group whose name does not appear on the manifest/Passenger Name List.



3. Documenting Travel Using the Passenger On-Board Record

a. A specimen of Form NRPC 3085 is reproduced below. Supplies of these forms are available at all crew base locations.

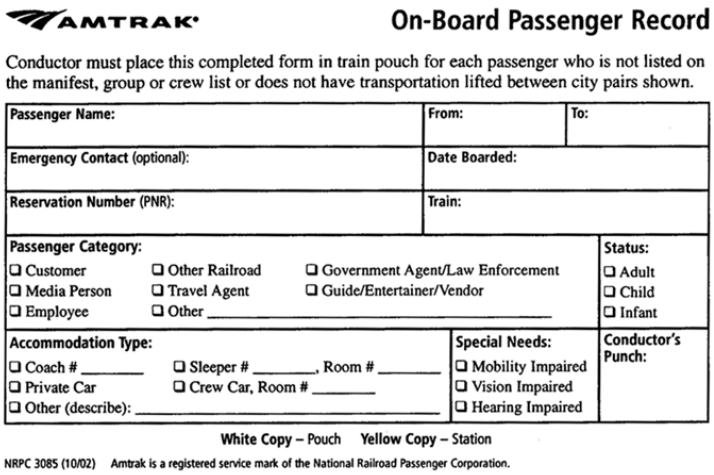
b. These are one-part, unnumbered forms, bound in booklets of twenty-five (25). Conductor(s) and Assistant Conductor(s) must ensure that all of the required information is provided on the forms, and must punch the form upon completion in the lower right hand corner to certify the record.

Specimen Form NRPC 3085

c. The following is a list of Amtrak trains for which these procedures apply:

Train Number	Train Name
1&2	Sunset Limited
3&4	Southwest Chief
5&6	California Zephyr
7&8/27&28	Empire Builder
11&14	Coast Starlight
19&20	Crescent
21&22	Texas Eagle
29&30	Capitol Limited
40&41	Three Rivers
48&49	Lake Shore Limited
50&51	Cardinal
52&53	Auto Train
58&59	City of New Orleans
89&90	Silver Palm
91&92	Silver Star
97&98	Silver Meteor
All	Acela Express
All	Metroliner
68&69/70&71	Empire Service

November 02



AMTRAK®

On-Board Passenger Record

Conductor must place this completed form in train pouch for each passenger who is not listed on the manifest, group or crew list or does not have transportation lifted between city pairs shown.

Passenger Name:	**From:**	**To:**
Emergency Contact (optional):	**Date Boarded:**	
Reservation Number (PNR):	**Train:**	

Passenger Category:
☐ Customer ☐ Other Railroad ☐ Government Agent/Law Enforcement
☐ Media Person ☐ Travel Agent ☐ Guide/Entertainer/Vendor
☐ Employee ☐ Other ____________________

Status:
☐ Adult
☐ Child
☐ Infant

Accommodation Type:
☐ Coach # _______ ☐ Sleeper # _______, Room # _______
☐ Private Car ☐ Crew Car, Room # _______
☐ Other (describe): ____________________

Special Needs:
☐ Mobility Impaired
☐ Vision Impaired
☐ Hearing Impaired

Conductor's Punch:

White Copy – Pouch **Yellow Copy** – Station

NRPC 3085 (10/02) Amtrak is a registered service mark of the National Railroad Passenger Corporation.

Appendix C

Passenger Train Two-Way End-Of-Train Device Regulations

As a result of previous Safety Board recommendations,[1] the Federal Railroad Administration (FRA) published a final rule[2] on January 2, 1997, amending the regulations governing train and locomotive power braking systems to require two-way end-of-train (EOT) devices[3] on a variety of freight trains. Passenger trains were exempted from the requirement because of the superior braking ratios of passenger cars and the presence of emergency brake valves ("conductor's valves") on each passenger car, which provide safety assurances not present on traditional freight trains.

Until recently, Amtrak had been increasing the number of express and mail cars on its long-distance intercity trains. Such cars, including the autorack-type cars on the Auto Train, are not equipped with emergency brake valves because they are unoccupied. "Mixed trains" like the Auto Train, which blend passenger and express service or autorack cars, are also usually much longer than most regular passenger trains. As the number of express cars increased on mixed passenger trains, the FRA became concerned that these trains were becoming more like freight trains than passenger trains, suggesting that the original rationale for exempting passenger trains from two-way EOT requirements may no longer apply. The FRA was also concerned about a mixed train's ability to stop within normal signal spacing after determining that there is a blockage in the trainline. Consequently, after conducting braking research through the Volpe Center, the FRA and Amtrak formulated two-way EOT device requirement criteria for mixed passenger trains as part of the Railroad Power Brakes and Drawbars regulations, 49 CFR Part 232.

As a consequence, the above-referenced regulation became effective on May 1, 1998. The following information summarizes the changes in the new regulation.

---

[1] See Safety Recommendation R-89-82 to the FRA to "Require the use of two-way end-of-train telemetry devices on all cabooseless trains for the safety of railroad operations," from *Collision and Derailment of Montana Rail Link Freight Train With Locomotive Units and Hazardous Material Release, Helena, Montana, February 2, 1989*, Railroad Accident Report NTSB/RAR-89/05 (Washington, DC: NTSB, 1989); and Safety Recommendation R-95-44 to the FRA to "Separate the two-way end-of-train requirements from the Power Brake Law notice of proposed rulemaking, and immediately conclude the end-of-train device rulemaking so as to require the use of two-way end-of-train telemetry devices on all cabooseless trains," from *Rear-End Collision of Atchison, Topeka, and Santa Fe Railway Freight Train PBHLA1-10 and Union Pacific Railroad Freight Train CUWLA-10 Near Cajon, California, December 14, 1994*, Railroad Accident Report NTSB/RAR-95/04 (Washington, DC: NTSB, 1995).

[2] Title 49 CFR 232.23 paragraphs (e) and (g) revised, and adding paragraph (h).

[3] A two-way EOT device consists of two radio telemetry devices, one in the controlling locomotive cab, and one mounted on the coupler and connected to the air brake hose (trainline) at the end of the train. The device provides the trainline pressure at the end of the train along with other customized information to the engineer in the controlling cab, and it can activate an emergency air brake application at the end of the train to overcome a possible trainline blockage and stop the train if necessary.

I. Passenger Trains Exempted from Two-Way EOT Requirement

A. Passenger trains operating at 30 mph or less;

B. Passenger trains on which the last car is equipped with an emergency brake valve that is readily accessible to a crewmember who has radio communication with the engineer; and/or

C. Passenger trains with 12 or fewer cars[4] with a car located no less than halfway back in the consist that has an emergency brake valve readily accessible to a crewmember; and/or

D. Passenger trains with 13 to 24 cars with a car no less than two-thirds of the way back in the consist that has an emergency brake valve readily accessible to a crewmember.

II. Passenger Trains Required to Have a Two-Way EOT

A. Those not exempted as specified above; and/or

B. Passenger trains that travel over 30 mph; and/or

C. Passenger trains with more than 24 cars.[5]

III. Operating Constraints on Passenger Trains Exempt from Two-Way EOT Requirements

When operating in mountain grade territory (average grade of 2 percent or greater for over 2 continuous miles), a passenger train that is exempted from having a two-way EOT must position a crewmember in radio communication with the engineer in the rearmost car equipped with a readily accessible emergency brake valve 10 minutes before the train descends the heavy grade and the crewmember must not leave until the train has traversed the heavy grade.

IV. Actions Concerning the En Route Failure of a Two-Way EOT on a Passenger Train

A. If a passenger train is required to have a (operable) two-way EOT device, and the device fails, the train is not permitted to descend a heavy grade (an average grade of 2 percent or more for 2 continuous miles) until an operable device is installed or an alternative method of initiating an emergency brake application from the rear (end) of the train is achieved.

---

[4] A *Roadrailer*, etc., is considered to be a car.

[5] The term "cars" in this context does not include locomotive units, unless the locomotive unit is "dead-in-tow," in which case the unit is treated like a car.

B. Passenger trains that develop en route failure of the two-way EOT device may continue to operate over track that is not in heavy grade territory as long as a crewmember occupies the rearmost car with a readily accessible emergency brake valve and remains in constant radio communication with the locomotive engineer. Also, the engineer must periodically test the braking characteristics of the train by making running brake tests. Each en route failure must also be corrected at the next location where necessary repairs can be conducted or at the next location where a required brake test is to be performed.

Appendix D

Chronological List of Track Maintenance Operations on Accident Curve Following Shoulder Ballast Cleaning

Date	Activity	MP Location	Rail Temp.	Slow Order Dates	Remarks
09-18-00 to 10-13-00	Shoulder ballast cleaning	Thru curve			
01-29-01	Surfacing	721.9-722.3			
03-20-01	Surfacing	722.4-722.9			
03-22/23-01	Surfacing	722.1-722.3			
03-27-01	Surfacing	722.1-722.3			
05-26-01	Rail defect	722.5-722.6		05-26-01 to 06-04-01	Not test car defect
05-30-01	Rail changed	722.5	128° F		
07-03-01	Surfacing	722.2-722.3		07-03-01 to 07-06-01	Hand-tamped
08-04-01	Surfacing	722.2-722.3		08-04-01 to 08-08-01	Hand-tamped
08-06-01	Surfacing	722.2	96° F	08-04-01 to 08-08-01	Hand-tamped
10-09-01	Surfaced full curve	722.1-722.5	92° F	10-05-01 to 11-23-01	Liner-tamper machine problems
10-11-01	Surfaced half curve	722.1-722.3		See above	Liner-tamper machine
11-19-01	Spot-surfaced	722.1-722.21	83° F	See above	Liner-tamper machine
12-20-01	Spot-surfaced	722.24			Hand-tamped
01-25-02	Spot in ties and surface	722.3	90° F	01-25-02 to 01-27-02	Hand-tamped
02-05-02	Surfacing	722.1-722.3		02-05-02 to 03-13-02	Hand-tamped
02-26-02	Spot-surfaced	722.1-722.3	90° F	See above	Liner-tamper machine

03-06-02	Concrete tie ballast-retaining wall installed			See above	
03-08-02	Added 70 tons of ballast	722.1-722.3		See above	
03-11-02	Surfaced	722.2-722.3		See above	Liner-tamper machine
03-25-02	Rail grinding			None required	
04-08-02	Replaced 5 ties	722.4	92° F	Put on and removed same day	Hand-tamped
04-09-2	Removed spikes and plates from under rail	722.3			
04-18-02	Derailment occurred	722.24			

Appendix E

Summary of Key Event Recorder Data

Event #	Time EDT	Feet ft	Speed mph	Throttle notch	Load amps	EOT psi	AB psi	BC psi	PCS	Emer	EOT Emer. Reqst.	Event
1	17:07:54	1362	56	Notch 8	832	108	110	0	Off	Off	Off	Locomotive passes over POD/kink @ ~1341 feet
	17:07:55	1279	56	Notch 8	832	108	110	0	Off	Off	Off	
	17:07:56	1195	56	Notch 8	832	108	110	0	Off	Off	Off	
	17:07:57	1112	56	Notch 8	832	108	110	0	Off	Off	Off	
2	17:07:58	1028	56	Notch 8	824	108	105	0	Off	Off	Off	Trainline pressure begins to drop
	17:07:59	945	56	Notch 8	824	108	102	0	Off	Off	Off	
	17:08:00	862	56	Notch 8	832	108	100	1	Off	Off	Off	
3	17:08:01	780	55	Idle	744	108	99	9	Off	Off	Off	Locomotive crew initiates emergency brake
	17:08:02	698	55	Idle	0	108	98	3	Off	Off	Off	
	17:08:03	617	55	Idle	0	108	45	10	On	Off	Off	
	17:08:04	537	54	Idle	0	108	0	35	On	Off	Off	
	17:08:05	459	53	Idle	0	106	0	68	On	Off	Off	
	17:08:06	382	52	Idle	0	106	0	85	On	Off	Off	
	17:08:07	306	51	Idle	8	106	0	88	On	Off	Off	
	17:08:08	234	49	Idle	64	106	0	87	On	Off	Off	
	17:08:09	170	43	Idle	144	106	0	84	On	Off	Off	
	17:08:10	116	36	Idle	144	106	0	46	On	Off	Off	
4	17:08:11	74	28	Idle	48	106	0	16	On	Off	Off	EOT registers emergency
	17:08:12	42	22	Idle	24	0	0	1	On	Off	Off	
	17:08:13	20	15	Idle	16	0	0	0	On	Off	Off	
	17:08:14	7	8	Idle	8	0	0	0	On	Off	Off	
5	17:08:15	4	1	Idle	0	0	0	0	On	Off	On	Engineer throws EOT switch
	17:08:16	3	1	Idle	0	0	0	0	On	Off	On	
	17:08:17	1	1	Idle	0	0	0	30	On	Off	On	
6	17:08:18	0	0	Idle	0	0	0	69	On	Off	On	Locomotive stops