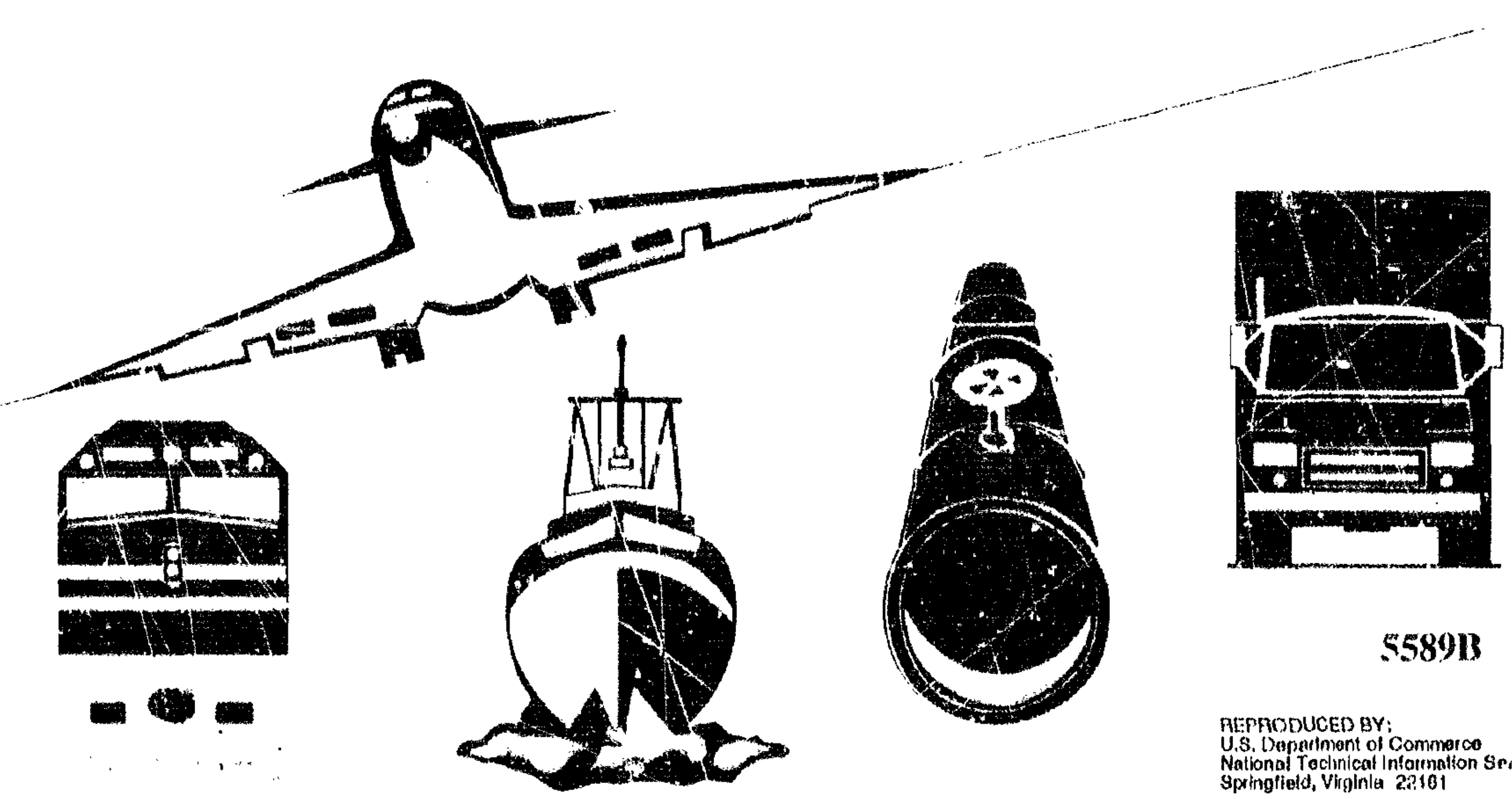
PB93-916303
NTSB/RAR-93/02

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

DERAILMENT AND SUBSEQUENT COLLISION OF AMTRAK TRAIN 82 WITH RAIL CARS ON DUPONT SIDING OF CSX TRANSPORTATION INC. AT LUGOFF, SOUTH CAROLINA, ON JULY 31, 1991



5589B

NTSB/RAR-93/02 PB93-916303

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

ADOPTED: September 13, 1993

NOTATION 5589B

Abstract: On July 31, 1991, National Railroad Passenger Corporation (Amtrak) train 82, Silver Star, was en route from Tampa, Florida, to New York, New York. At 5:01 a.m., its last six passenger cars derailed at milepost S329.6 on CSX Transportation Inc. track in Lugoff, South Carolina. Twelve on-board service crewmembers and 53 passengers sustained minor injuries, 12 passengers sustained serious injuries, and 8 passengers sustained fatal injuries.

The safety issues discussed in this report include adequacy of switch inspections, adequacy of track inspection program, postaccident performance of Amtrak personnel, delay in emergency response, and timeliness of toxicological testing.

As a result of its investigation, the Safety Board issued safety recommendations to CSX Transportation Inc. and the National Railroad Passenger Corporation.

CONTENTS

EXECUTIVE SUMMARY

On July 31, 1991, National Railroad Passenger Corporation (Amtrak) train 82, Silver Star, was en route from Tampa, Florida, to New York, New York. The train consisted of 2 diesel-electric locomotives, 3 baggage cars, and 15 passenger cars.

At 5:01 a.m., its last six passenger cars derailed at milepost S329.6 on CSX Transportation Inc. track in Lugoff, South Carolina. The accident occurred near the E.I. DuPont May plant on a single main track that has a parallel auxiliary track, which is known as the DuPont siding. The derailment occurred at the Orlon crossover switch that connects the main track and the auxiliary track. The derailed passenger cars collided with the first of nine hopper cars that were stored at the siding.

Six operating crewmembers, 16 on-board service crewmembers, and 407 passengers were on the train. Twelve on-board service crewmembers and 53 passengers sustained minor injuries, 12 passengers sustained serious injuries, and 8 passengers sustained fatal injuries.

The National Transportation Safety Board determines that the probable cause of this derailment was the opening of the switch points under Amtrak train 82 because of a poorly maintained switch as a result of inadequate track inspections, switch maintenance, and management oversight.

The safety issues discussed in this report include:

- adequacy of switch inspections,
- adequacy of track inspection program,
- postaccident performance of Amtrak personnel,
- delay in emergency response, and
- timeliness of toxicological testing.

The Safety Board makes recommendations addressing these issues to CSX Transportation Inc. and the National Railroad Passenger Corporation.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

DERAILMENT AND SUBSEQUENT COLLISION OF AMTRAK TRAIN 82 WITH RAIL CARS ON DUPONT SIDING OF CSX TRANSPORTATION INC. AT LUGOFF, SOUTH CAROLINA, ON JULY 31, 1991

INVESTIGATION

The Accident

On July 31, 1991, National Railroad Passenger Corporation (Amtrak) train 82, Silver Star, was en route from Tampa, Florida, to New York, New York. The train consisted of 2 diesel-electric locomotives, 3 baggage cars, and 15 passenger cars. At 5:01 a.m., its last six passenger cars derailed at milepost (MP) S329.6[1] on the CSX Transportation Inc. (CSXT) main track at the Orlon crossover in Lugoff, South Carolina. The train was travelling north on straight track with a clear signal indication[2] at a recorded speed of 80 miles per hour (mph). The maximum authorized CSXT timetable speed at the site of the accident is 79 mph.

The accident occurred near the E I. DuPont May plant on a single main track that has a parallel auxiliary track. The derailment occurred at the Orlon crossover switch that connects the main track and the auxiliary track, which is known as the DuPont siding. (See figure 1.) The last six passenger cars (13 through 18) derailed, moving left (westward) toward the siding. The cars collided with the first of nine hopper cars that were parked north of the Orlon crossover at the south end of the siding. The collision caused a hopper car to turn over and a wheel set (an axle and a pair of wheels) from the first hopper car to penetrate the west side of the last passenger car. The derailed passenger cars came to rest 1/4 mile north of the Orlon crossover. They remained upright and parallel to the track.

---

[1]Numbers increase to the south.

[2]Authorizes a train to proceed at the maximum authorized speed and indicates that no traffic is in the block and that all switches are lined for the main track.

After the accident, the main track crossover was found to have the connecting rod disconnected from the switch stand crank. The switch point was not secured to the stock rail, the cross pin that attached the switch stand crank to its spindle was not in place, and the crank had dropped onto the safety plate. The cross pin was found near the switch stand. (See figure 2.)

Six operating crewmembers (an engineer, a qualifying engineer, a fireman, a conductor, and 2 assistant engineers), 16 on-board service (OBS) crewmembers, and 407 passengers were on the train. Twelve OBS crewmembers and 53 passengers sustained minor injuries, 12 passengers sustained serious injuries, and 8 passengers sustained fatal injuries.

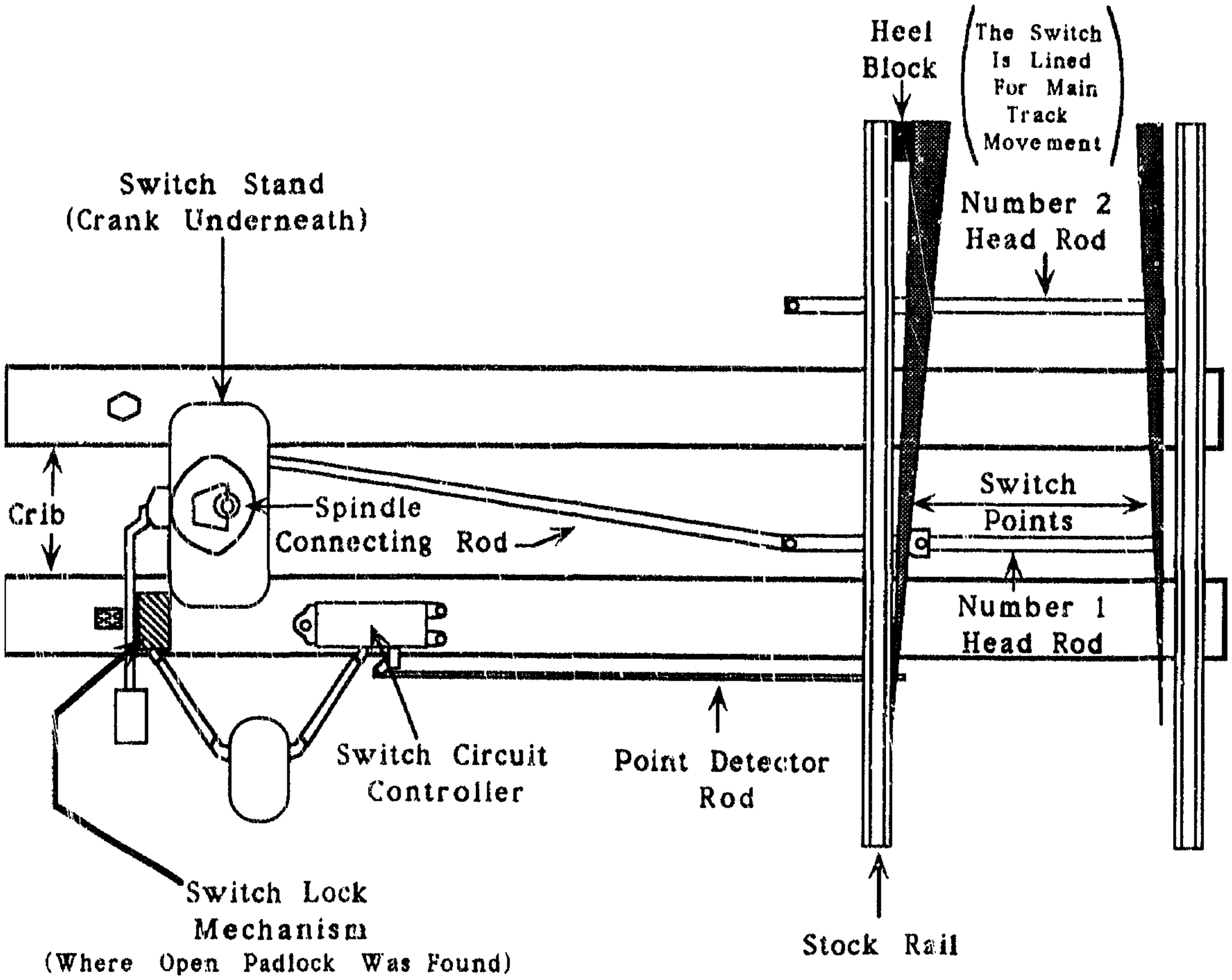
After the train stopped, the engineer tried to radio the CSXT dispatcher in Jacksonville, Florida. According to the CSXT radio log, the dispatcher received an emergency tone from the Lugoff area at 5:04 a.m. The dispatcher responded, but the engineer could not hear him because the transmitter board at the Lugoff base station was defective, which the dispatcher did not know. If he had known the transmitter was defective, he could have used the radio base station at Cayce Yard, the nearest CSXT rail yard office. However, because the dispatcher could hear the engineer, he thought the engineer could hear him. After several minutes, the qualifying engineer[3] tried to contact the dispatcher by using the radio in the second locomotive. Again the dispatcher responded but could not be heard. At 5:08 a.m., the engineer successfully contacted Cayce Yard personnel who acknowledged the message and called the Richland County emergency operator.

The dispatcher and the assistant chief dispatcher monitored the conversation between the locomotive crew and Cayce Yard and heard the engineer give his location as "the Lugoff crossover." At 5:12 a.m., the assistant chief dispatcher called the Kershaw County emergency medical services (KCEMS), advised them of the accident, and stated that the train was between Lugoff and Camden, South Carolina. (Both Lugoff and Camden are in Kershaw County.) (See figure 3.)

About 5:12 a.m., the engineer called Cayce Yard again and gave a more explicit location "at the crossover into the Dupont plant at Lugoff." The Kershaw County Sheriff's Department located the train at 5:24 a.m.

---

[3]Amtrak qualifying engineers must be qualified by Amtrak management on CSXT trackage through an operational test and then must be certified by CSXT management on a qualifying trip to become a certified engineer.



Drawing Not To Scale
Source: NTSB

Figure 2.--Diagram of switch stand.

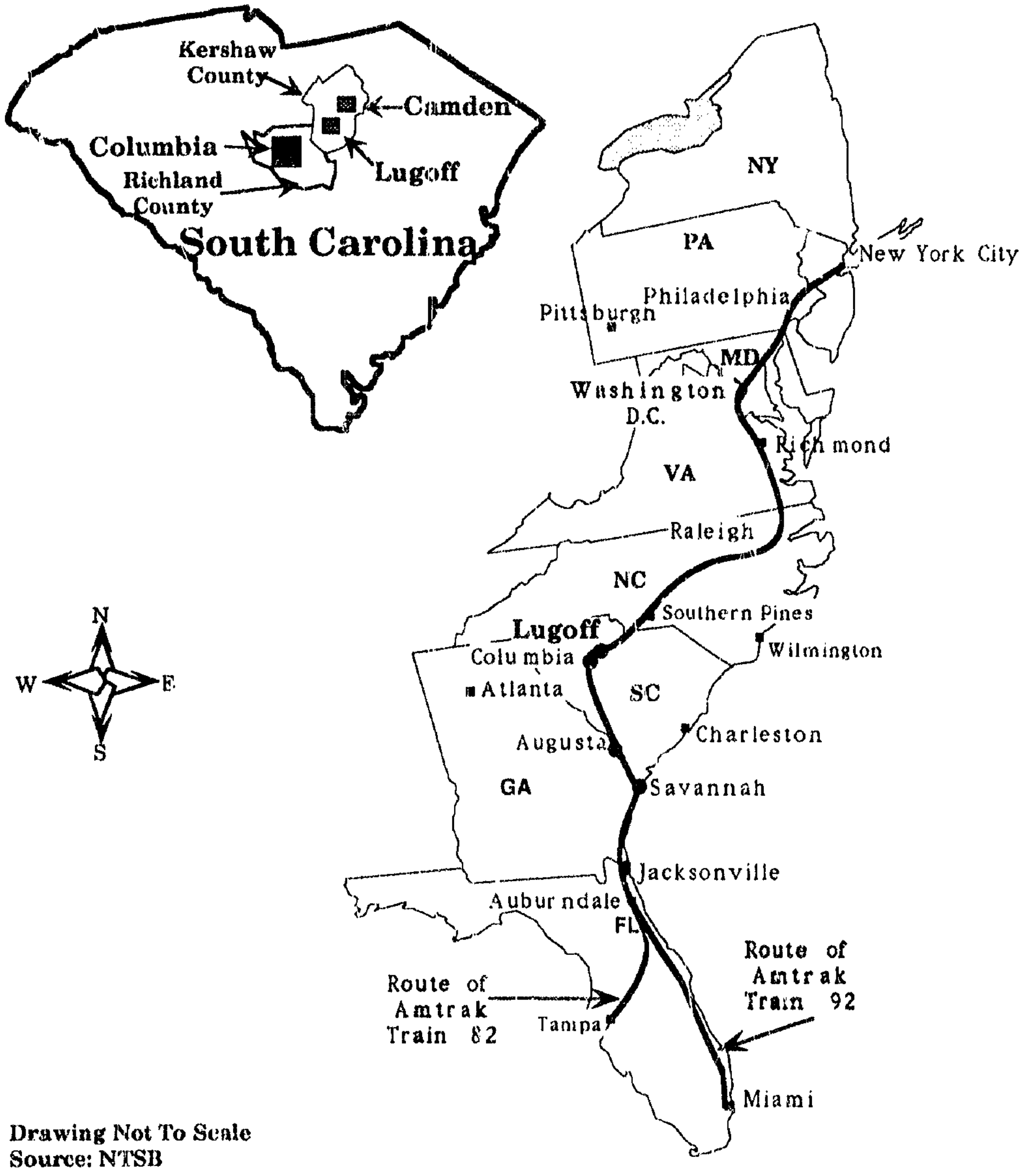


Figure 3.--Maps of South Carolina and of train route.

Injuries

	Operations Crew	OBS Crew	Passengers	Total
Fatal	0	0	8	8
Serious	0	0	12	12
Minor	0	12	53	65
None	6	4	334	344
Total	6	16	407	429

Damage

The last six passenger cars derailed. The 13th car showed minor damage, and the 14th, 15th, and 17th cars showed substantial damage. The left (west) sides of coaches 25060 and 26002, the 16th and 18th cars, respectively, were severely damaged. Coach 26002 had a wheel set in its left midsection. (See figure 4.) The first two hopper cars were damaged on their east sides and undercarriages.

According to the CSXT, about 100 ties, 1,600 feet of rail, and 2 turnouts (switches) at the Orlon crossover were replaced as a result of the accident.

The CSXT and Amtrak provided the following damage estimates:

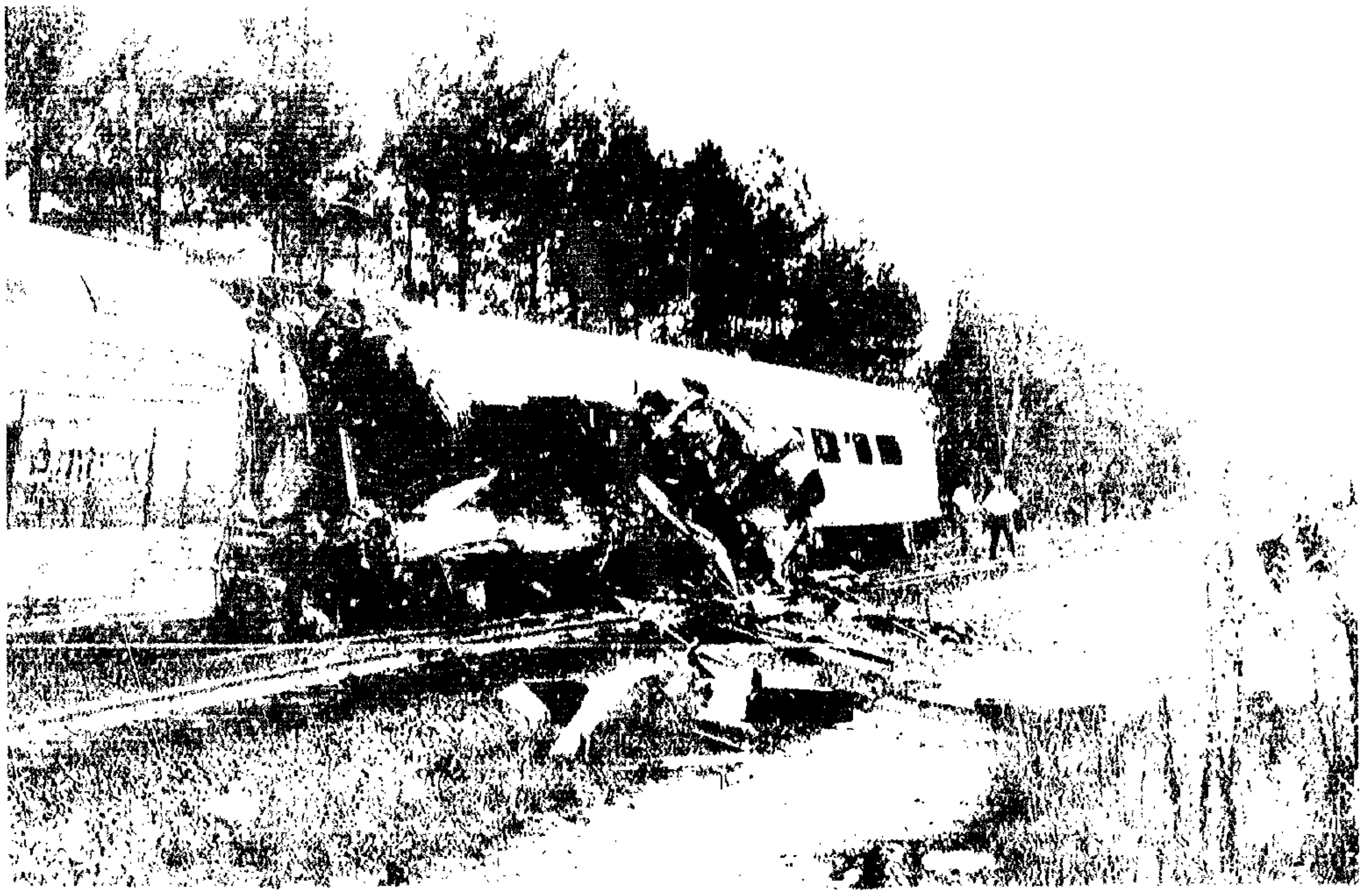
Equipment	$2,868,000
Track	10,000
Signal	2,000
Total	$2,880,000

Personnel

Engineer.--In 1973, Seaboard Coast Line[4] hired the engineer as a fireman. In 1976, he passed a test to qualify as an engineer. In 1986, he became an Amtrak employee after Amtrak assumed passenger operations on the territory. In August 1990, he began to operate exclusively as an engineer and was assigned to the extra board. He passed both his last air-brake test and his last CSXT rules exam in 1990. In April 1991, he became the engineer on train 82. During the 11 months before the accident, he had been making three round trips each week between Jacksonville, Florida, and Southern Pines, North Carolina. Two weeks before the accident, he passed efficiency tests. He had no record of disciplinary action.

---

[4]The predecessor of the CSXT.



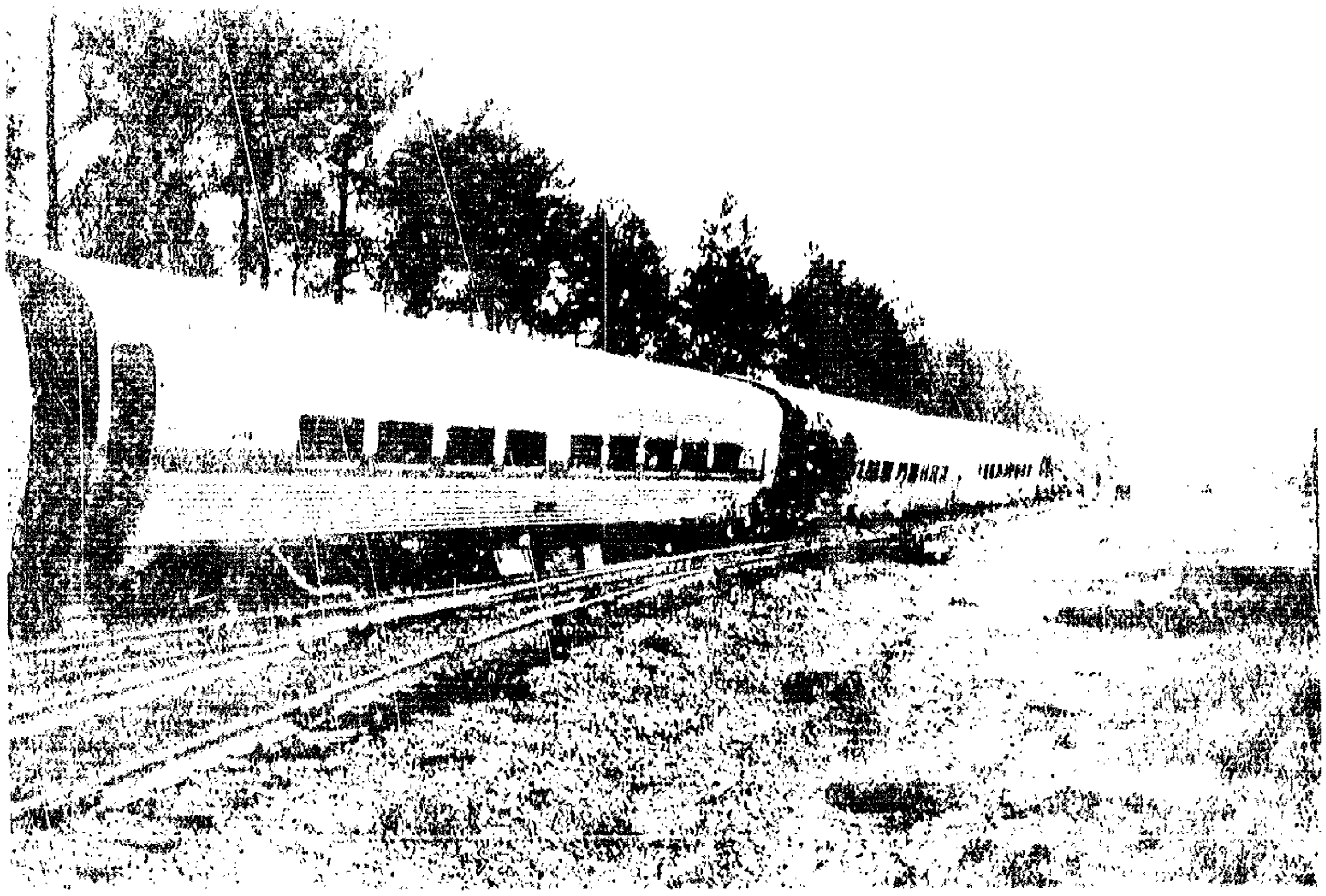


Figure 4 – Photographs of derailed cars

Fireman.--The fireman began his career in 1974 when the Baltimore and Ohio Railroad hired him as a brakeman. In 1979, he passed a test and qualified as a fireman, and in 1980, he was tested again and became an engineer. He operated as an engineer until 1984. In 1985 and 1986, he functioned only part time as an engineer because of union duties. In 1986, he moved to Jacksonville as manager of labor relations for the CSXT. In 1987, he left the CSXT and worked outside the rail industry. In 1990, Amtrak hired him as a fireman. He passed his last CSXT rules exam 6 months before the accident. He became the fireman on train 82 3 months before the accident. Two weeks before the accident, he passed efficiency tests. He had no record of disciplinary action.

Qualifying Engineer.--The qualifying engineer was hired by the Pennsylvania Railroad as a yard brakeman in 1957. Until 1970, he worked as a brakeman and a fireman. After moving to the Chicago and Northwestern Railroad, he took a qualification test in 1970 and was promoted to engineer. In April 1973, he joined Seaboard Coast Line and was promoted to engineer 8 months later. In 1987, he transferred to Amtrak, was again tested, and was subsequently assigned as an engineer. Two months before the accident, he was assigned to train 82 to qualify on the territory. He successfully completed his last air-brake test 2 weeks before the accident and the CSXT rules exam on October 13, 1990. He passed efficiency tests on July 17, 1991. He had no record of disciplinary action.

Roadmaster.--Seaboard Coast Line hired the roadmaster as a trackman in 1965. In 1970, he became a machine operator, and the CSXT qualified him through rules classes and on-the-job training as a track inspector, as the Federal Railroad Administration (FRA) requires. In 1972, he became an apprentice foreman. In 1978, he became an assistant foreman, then a foreman, and finally an assistant roadmaster. In 1980, he became roadmaster of the Lugoff area, the position he was holding when the accident occurred. (His territory covered approximately 180 miles of main line track, 300 switches, and 2 yards. He supervised 12 employees.) The year before the accident, he attended a CSXT-conducted review of FRA rules. About 10 weeks before the accident, he passed a CSXT operating rules exam.

Track Inspector.--Seaboard Coast Line hired the track inspector as a trackman in 1968. He was promoted to apprentice foreman in 1969 and to foreman in 1975. At the time of the accident, he had worked for 23 years as a track foreman in the district that included the Lugoff area. The CSXT qualified him through rules classes and on-the-job training to inspect track in 1972. Each year since then, he had passed an operating rules test that covered the FRA track safety standards inspection procedures. He took his last test 2 months before the accident.

Trackman.--The Seaboard Coast Line hired the trackman in 1969. In 1982, he became an apprentice foreman, the position he was holding when the accident occurred. In 1985, the CSXT qualified him through rules classes and on the-job-training to do FRA track inspections. He had worked with the track inspector until the accident. The trackman passed his last operating rules exam 3 months before the accident.

On-board Service Crew.--The OBS crew chief had 9 years experience in OBS. The crew chief supervised six food service employees and nine car attendants. The car attendants are responsible for helping passengers in emergencies, coordinating the passengers' seat assignments, explaining train procedures to passengers, and keeping coach and sleeping cars clean.

First-aid training is optional for Amtrak OBS crewmembers. Six members of the OBS crew on train 82 said that they had such training. Amtrak gives newly hired OBS crewmembers 4 hours of training in handling emergencies and has "no written policy mandating a certain frequency of emergency situations refresher training for on-board service employees." Records showed that some of the OBS crewmembers had refresher training in 1990 but that one had not had any since 1984. Of the 16 OBS crewmembers, 3 could not remember attending emergency training. One crewmember's records could not be located, and he could not remember receiving first-aid or emergency training. Those who remembered attending stated that their emergency training helped them after the derailment.

Train Information

General.--Train 82 was a combination of two trains. The first train (82) originated in Tampa and consisted of locomotive 403 and eight cars. The second train (92) originated in Miami, Florida, and consisted of locomotive 257 and 10 cars. The trains were combined in Auburndale, Florida. The locomotive crew, who operated the combined train 82 when the derailment occurred, had taken over in Jacksonville and were destined for Southern Pines, North Carolina. The train, itself, was en route to New York.

Train 82.--Train 82 consisted of two diesel-electric F40PH locomotive units, three baggage cars, eight coaches, two lounge cars, three sleepers, a diner, and a buffet car. (See appendix C.)

The locomotive units, built by the General Motors Electro-Motive Division, were each equipped with 3,000-horsepower engines, two four-wheel trucks, and a 1,800-gallon fuel tank. Each locomotive unit had a 97-channel radio, schedule 26L air-brake equipment, speed indicators, and an over-speed limit control with a warning whistle.

Locomotive 403, the lead unit, had a multi-event recorder system that measured and recorded on a magnetic tape cartridge the elapsed time, distance, speed, traction motor and dynamic brake amperage, throttle position, automatic and independent brake application, and travel direction.

The day before the accident, locomotive 403 was inspected in Tampa. CSXT carmen conducted an initial terminal air-brake test on the locomotive unit before it departed. The equipment condition report (Amtrak MAP 100 form) was found on the locomotive unit after the accident. The report noted that at Jacksonville, the unit had an inoperable dynamic brake. No other discrepancies or problems for either locomotive unit were noted at the points of origin or during the trip.

The engineer stated that when he took charge of the train in Jacksonville, the equipment already was assembled and had an initial terminal air-brake test. He reported that the train handled normally and that the crew alerter was functional.

Derailed Cars.--Of the six derailed passenger cars, one was an Amfleet II lounge car, three were 25000 coach series Amfleet II cars, one was a 26000 coach series Amfleet II car and one was a Heritage series sleeper car. All had stainless steel car bodies. The cars were built by the Budd Company of Philadelphia, Pennsylvania.

Hopper Cars.--Eight of the nine hopper cars on the south end of the DuPont siding were empty. The loaded hopper car was the second car from the north end.

Track Information

Description.--West of the tracks is the E.I. DuPont May plant. East of the tracks are a dirt access road and a wooded area. Lachicotte Road grade crossing is south of the Orlon crossover. Both the main and siding tracks are aligned north and south. (See figure 1.) At the Orlon crossover, the track is level. North of the crossover, the track descends at 0.25 percent.

The track is constructed of 115.25-pound continuous welded rail, which was manufactured in 1961 and installed in 1962. The main track was box anchored. Anchors were installed on the rail at each side of the tie at every tie except at the switch points. Rails were fastened to the ties with rail and plate holding spikes. The road bed consisted of crushed granite number 4 stone ballast, which had been renewed in 1990. The ballast was 9 inches deep at the switch point.

The Orlon crossover consisted of 115.25-pound rail and two manually operated switches, which were installed in 1962. The main track switch consisted of a number 10 turnout with uniform risers, two 16-foot 6-inch switch points, and a number 10 frog.[5] The main track switch at the Orlon crossover had a 51-A New Century Bethlehem switch stand (see figure 2), as did the siding switch. According to the CSXT engineering department, the metal safety plate under the main track switch stand was installed (date unknown) after the switch stand was installed in 1962. Consequently, the stand had to be unfastened so the safety plate could be put in place. Both the stand and the safety plate shared the same spikes. The safety plate was designed by CSXT and manufactured by Bethlehem Steel Corporation.

---

[5]A frog is a device at the intersection of two tracks that permits the wheels and flanges on one track to cross to the other.

Inspection.--The CSXT designated the main track as FRA class 4.[6] The CSXT main track and switches must be inspected to comply with the FRA class 4 track safety standards and the CSXT engineering standards.

According to the track inspection records, the CSXT inspected the Orlon main line crossover switch 55 times in the 3 months preceding the accident. The roadmaster did 4 inspections, the track inspector and the trackman's assistant did 44, and five other maintenance-of-way employees did 7.

The CSXT inspectors are guided by the FRA track safety standards in the CFR and by the CSXT *Engineering Department Maintenance Rules*. According to the FRA track safety standards,[7]

> Each switch point must fit its stock rail properly, with the switch stand in either of its closed positions to allow wheels to pass the switch point. Lateral and vertical movement of the stock rail in the switch plates or of a switch plate on a tie must not adversely affect the fit of the switch point to the stock rail; and the switch connecting rod must be securely fastened.

The CSXT requires an annual, joint, signal, track, switch, and turnout inspection, requiring the switch to be disassembled. According to the *Engineering Department Maintenance Rules,*

> Turnouts, crossovers, and rail crossings require thorough and careful inspection and maintenance. They shall be kept clean and free from sand, dirt, ice, snow, and other debris.
>
> Bolts shall be kept tight in frogs, switches, crossing and slip switches. Where provision is made for cotter pins, they shall be kept in place. Bolts fastening switch rods to clips and to connecting rod shall be placed with nuts up and provided with cotter pins. When wear becomes apparent between bolts and clips or rods, the bolts must be immediately replaced.
>
> The Foreman must carefully observe main track switches each time he passes them, and immediately repair any defects found.

---

[6]According to 49 Code of Federal Regulations (CFR) 213.9, class 4 track is maintained to allow speeds of 80 mph for passenger trains and 60 mph for freight trains.

[7]Title 49 CFR 213.135.

The Roadmaster is responsible to see that the inspection of track is performed in a manner and frequency to ensure that the track is safe for operation at a maximum authorized speed.

All bolts must be in place and tight with cotter pins provided and visible where required.

The roadmaster and signal supervisor conducted the last annual switch and turnout inspection at the Orlon crossover on October 26, 1990. According to the roadmaster's testimony and to documentation, they did not disassemble the switch as they were required to do in the annual inspection. They did not note any conditions requiring repair. When the roadmaster was asked whether he remembered whether the cross pin and the retaining ring were in place, he answered, "If I made the inspection, it was in place."

The roadmaster and the track inspector testified that they had observed that the crib between the switch ties around the switch at the Orlon crossover was full of ballast, but that they had not done anything to remove any ballast. Ballast in the crib area of the throw rod could adversely affect the movement of the switch components.

The track inspector testified that he periodically received complaints from traincrews about the difficulty of throwing (operating) the Orlon crossover switch. When he received a complaint, he had the switch points cleaned and graphite (a dry lubricant) applied.

Inspection records from the May, June, and July before the accident did not reveal any switch defects; although, in June an inspector noted and replaced a missing bolt on the main track frog in the Orlon crossover. The roadmaster testified that on July 8, 1991, the day on which he did his last inspection before the derailment, he did not observe that the cross pin was broken (National Transportation Safety Board investigators found the cross pin broken) and that his assistant operated the switch without noting problems.

The track inspector's assistant was the last person to do a walking switch inspection. He did it on the day before the accident between 10 and 10:30 a.m. He stated that he had operated the switch and that the switch points fit tightly against the stock rail.

On July 9, 1991, 22 days before the accident, the CSXT performed a track geometry inspection and did not note any irregularities at the accident site. (However, the track geometry car is not used to inspect for anomalies through a switch or a crossover because of the physical characteristics of the track components.)

The CSXT routine inspections on the territory before the accident included:

1. The last track and switch inspection by the roadmaster was done on July 8, 1991. (The CSXT requires that the roadmaster make frequent inspections to ensure safe track.)

2. The last track inspection by the track inspector and his assistant was done on July 30, 1991. (Both the CSXT and the FRA require that track inspectors make twice weekly track inspections.)

3. The Orlon crossover switch was last inspected by the track inspector and his assistant on July 30, 1991, the day before the accident. (The CSXT requires main track switch inspections each time the inspector passes a main track switch on the twice weekly inspections. Any defect found is to be repaired. The FRA requires a switch inspection monthly.)

4. A switch and turnout inspection was done on October 26, 1990. (The CSXT requires an annual switch and turnout inspection. The inspection requires disassembly of the switch mechanism to inspect for broken, worn, or defective parts.)

5. A main track geometry inspection was done on July 9, 1991. (The CSXT requires an annual main track geometry inspection.)

The FRA requires that one of its inspectors make a periodic track inspection critique of the CSXT trackman's inspections and review the CSXT records for compliance with the FRA track inspection recordkeeping requirements. An inspector, working for the FRA, did a CSXT track inspection evaluation on June 26, 1991. Between MPs S362.3 and S326.2, the FRA employee was accompanied by a CSXT track inspector. No track deficiencies were noted at MP S329.6, and no switch deficiencies were noted.

The FRA inspector did observe several problems nearby: three center joint bars were cracked at MP S349.0, a frog bolt was missing at MP S346.4, bolts on two guard rails were loose at MP S339.2, and trees were growing in the signal pole lines between MPs S332.4 and S332.2.

The FRA track safety standards for class 4 track require the CSXT to inspect the main track twice a week and to inspect all switches on it once a month. The CSXT requires that each weekly CSXT switch inspection comply with the monthly FRA switch inspection requirement. Because of the twice weekly track inspections, FRA switch inspections are made up to eight times per month beyond the one FRA monthly inspection required. According to the roadmaster, he, the track inspector, and the trackman inspect a 180-mile territory of main line track twice a week. In addition to the main track inspections, they also inspect siding tracks once a week and industrial sidings once a month. The CSXT roadmaster is expected to do monthly inspections of 300 switches and 2 yards, of which one yard has a capacity of 800 cars.

The roadmaster has divided inspections on the territory into two inspection areas and two inspection teams. Each team does half of the territory two times a week. He said that each day he inspected approximately "35 miles of track and 25 to 30 switches and the track inspector and trackman together inspected another 35 miles of track and 25 to 30 switches."

The CSXT chief engineer, who is in charge of the track department track and switch inspections, confirmed the roadmaster's estimate that it took 10 to 15 minutes for a switch inspection. The chief engineer also stated that under some circumstances, it could take up to 20 minutes to complete a switch inspection.

The roadmaster said that whenever either he or one of the inspectors did a track inspection and passed a switch, whoever it was stopped and did a manual switch inspection by "looking at" and operating the switch according to the CSXT engineering inspection standards. He said, "If you don't find anything wrong with a switch that requires repair, you can do an inspection in about 10 to 15 minutes."

The roadmaster added that he believed the time for inspections is adequate, although during the past 11 years, the manpower assigned to the territory had been reduced by 50 percent. The territory had remained the same, but the additional work had been accomplished due to mechanization.

The overall reduction in maintenance-of-way employees, according to the CSXT, has been accomplished through the automation and mechanization of the work. However, the number of track inspectors has increased during the same time period. In addition, the use of hi-rail vehicles and new communication methods, as well as fewer turnouts, has made it possible for track inspectors to cover much larger territories.

The track inspector said that keeping up with the daily schedule of track inspection, maintenance, and repair did not allow him enough time to perform adequate switch inspections. The track inspector stated that if the switch points fitted properly, he did not generally check everything.

The FRA requires railroads to keep records of track and switch inspections, but it does not state in 49 CFR 213 the format the records must meet. The roadmaster, track inspector, and trackman maintained the records by logging all track and switch inspections on the same document. The roadmaster testified that the inspection of a switch was documented by writing at the bottom of the report "all switches between two points were inspected." A specific switch was mentioned only if it was found to have a defect that was to be reported to the CSXT management to schedule for correction.

Postaccident Switch Examination

A train cannot enter a crossover unless the switch points on the switch on the main track have been opened. The switch points are opened and closed by throwing the switch handle, which rotates the switch spindle inside the switch stand. The switch crank connects to the square shaft with a cross pin, which holds the crank on the shaft. The cross pin is not intended to transmit rotational loads, but is intended only to keep the crank on the spindle. The spindle and crank rotate together, causing a lug on the end of the crank to move either toward or away from the track. The switch connecting rod is assembled over the lug on the end of the crank. When properly assembled, the switch, by design, has insufficient clearance between the connecting rod and the underside of the switch stand housing for the connecting rod to disengage from the lug. As the crank lug moves, it pushes and pulls the connecting rod, which moves the number 1 head rod. As the head rod moves, it opens or closes the switch points. (See figure 5.)

The safety plate under the switch stand, which is between the switch stand and the ties, is intended to keep the crank and the square shaft of the spindle connected, even without a cross pin in place.

The examination of the Orlon crossover switch after the derailment revealed that the cross pin that holds the crank to the spindle was not in place, which allowed the crank to drop onto the safety plate. The crank left rub marks on the safety plate, which indicates that the crank had been thrown while the crank was contacting the plate. The crank and spindle were not deformed in any way, and when the cross pin holes on the crank and the spindle were realigned after the accident, the crank resumed its proper distance from the safety plate.

A 2-inch piece of the cross pin was found lying on top of the ballast below the switch stand. A 1.25-inch piece was buried in the ballast about 3 inches deep, which violates FRA regulations.

When initially examined at the accident scene, the connecting rod was not connected to the lug on the end of the crank, but was found on the ballast next to the crank. Rub marks were evident on the underside of the switch stand housing and on top of the connecting rod.

The tie crib at the switch stand was full of ballast. Ballast and debris under the switch stand between the ties was excessive and rubbed against the bottom of the connecting rod, the number 1 head rod, the number 2 head rod, and the switch lock rod. Some ballast and debris was found on the safety plate. (See figure 6.)

Track surface measurements were conducted by the FRA. A track cross level irregularity of 1 5/16 inches was found with the track under load between the point of derailment to approximately 31 feet south. The FRA safety standards for class 4 track allow a maximum variation of 1 1/4 inches from a level surface. The FRA cited the CSXT with a violation for the 1/16-inch defect.

The Safety Board examined 3.5 feet of the left-hand switch point. The point was worn to a ramp shape over a distance of 2.75 inches from the point end. The point had two impact marks. One mark extended from 0.25 inch from the south end of the point for 5 inches. The other mark started directly on the top of the point about 0.5 inch from the point end, progressed to the gauge side, and extended back 2.75 inches. The clips of the number 1 and number 2 switch rods, which were attached to the left switch point, had small cracks.

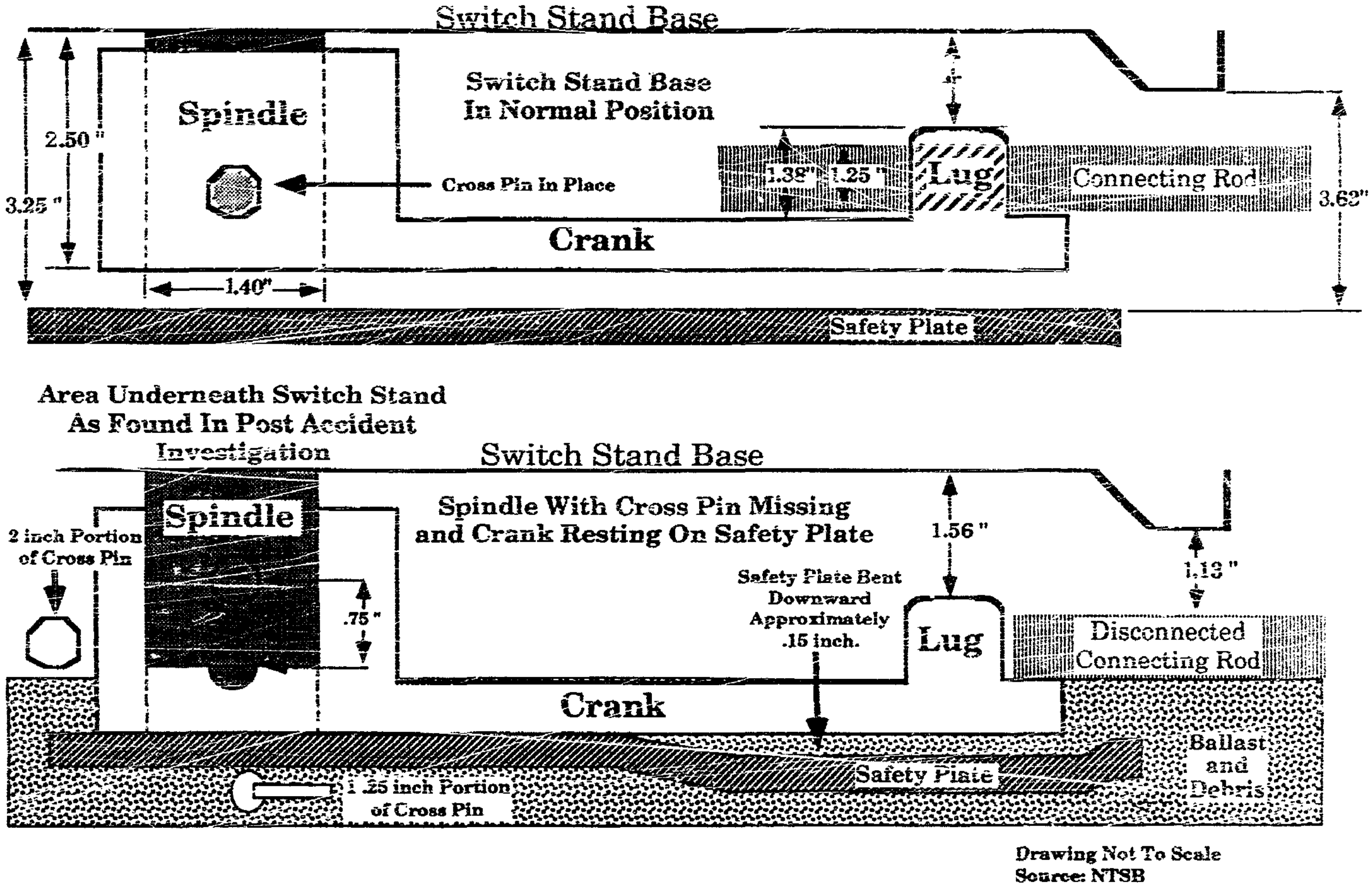


Figure 5.--Diagram of crank showing spindle and connecting rod.

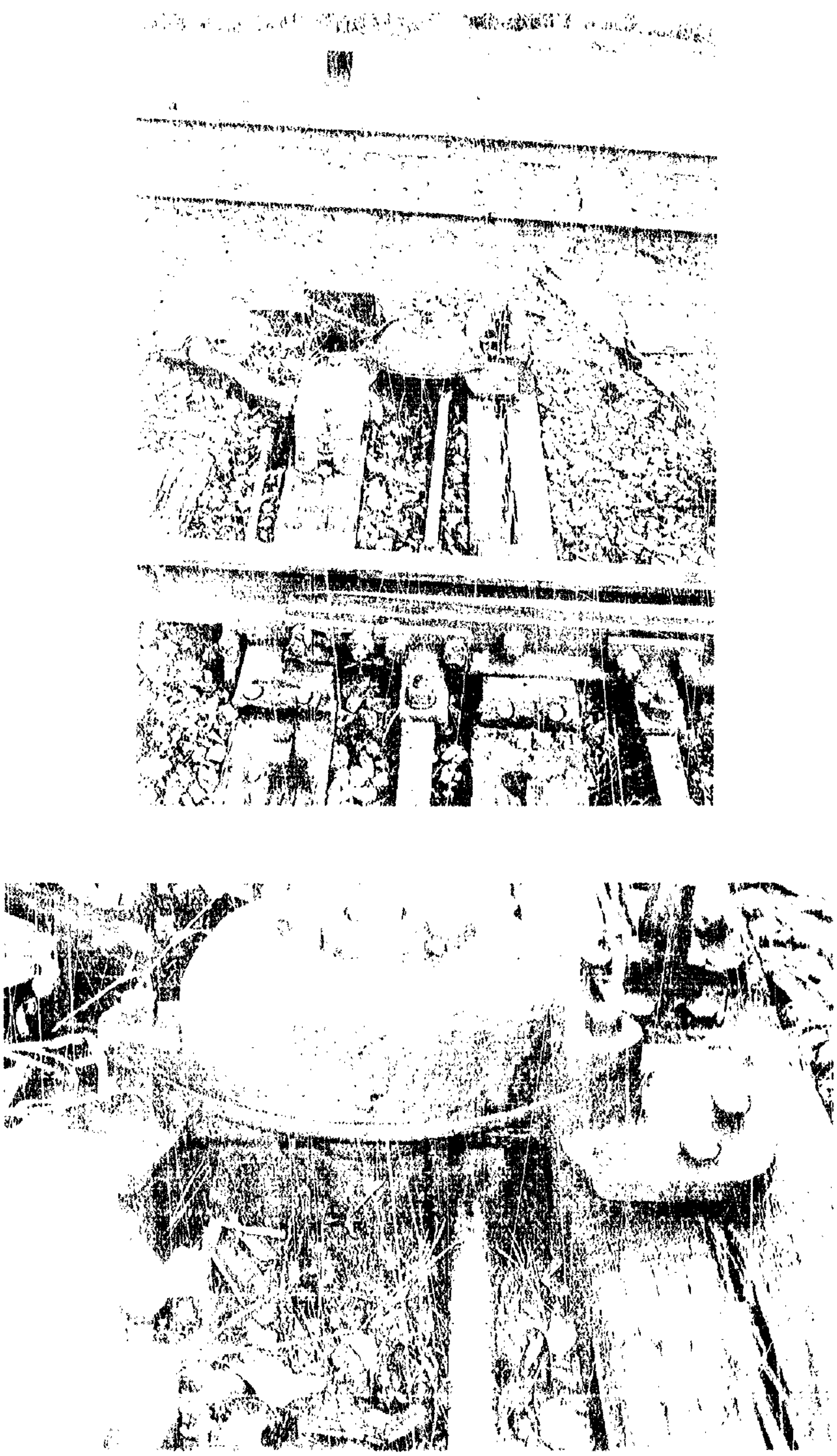


Figure 6.--Photographs of switch stand and connecting rod.

The Safety Board also examined 3.5 feet of the right-hand switch point. The point had been bent to the right for 15 inches, and the top had been impacted and curled to the right 0.5 inch to 6 inches from the end. The point was cracked between 2.75 and 8.5 inches longitudinally about 0.5 inch below the top. About 10 inches from the point end, a 2.5-inch section of the top was torn and separated from the switch rail.

Normally when the switch points are positioned for the main line, the left-hand switch point is flush against the left-hand stock rail, and the right-hand switch point is 4 to 5 inches from the right-hand stock rail. When the switch rails are positioned for movement between the main line and the siding, the left-hand switch point is 4 to 5 inches from the left-hand stock rail, and the right-hand switch point is flush against the right-hand stock rail. Safety Board investigators found the left- and right-hand switch points open 3 inches and 7/8 inch from their respective stock rails.

Cut plate shims between the switch points and the switch point clips were in place for added adjustment. The curved closure rail was broken, was turned outward, and had broken the joint bars at the toe of the frog. Four bolts were broken on the left-hand heel block; no evidence of bending was noted next to the separations. After a visual examination of the bolts, the fracture surfaces revealed features typical of overstress tensile separations. No evidence of preexisting defects, such as fatigue cracking or substantial corro ion, was noted.

Signal/Communications

Signal.--The signal system is a traffic control system with intermediate automatic block signals. It is controlled by a computer-aided dispatching system in Jacksonville. The accident occurred between two signal control points, one at the north end of Lugoff and the other at the south end of Camden.

At 5:01 a.m., according to the Jacksonville signal log, train 82 occupied the block[8] at the north end of Lugoff, approximately 1/2 mile south of the Orlon crossover. After the accident, the traffic control system and radio communication between the operating crew and the dispatcher were used to determine the location of the train. Both methods provided an approximate location.

Signal Inspection.--The signal system at the accident site was secure and functioning. The electric switch lock mechanism was tested to ensure that the switch lever could not be disengaged from the lock stand, and the lock worked as designed. The manual switch was electrically locked with a Union Switch & Signal Company SL21 locking mechanism. The circuit controller was working as designed. The switch circuit controller was securely fastened to the ties. The switch circuit controller housing was tight and was dry inside. The switch point detector rod was in place. All signal tests were current, except the time element relay test. It was overdue and should have been done by June 14, 1991.

---

[8]A length of track that is governed by block signals.

The padlock to the housing cover of the electric switch lock control was in place, but would not lock. No indication of tampering was found. The day after the accident, the FRA cited the CSXT for exposing the electric switch lock to unauthorized entry.

Communications.--The subdivision that includes the Lugoff area uses a dispatcher radio system, consisting of a wayside radio with dispatcher, road, and maintenance-of-way channels. The dispatcher channel is controlled from Jacksonville. A crewmember can talk to the dispatcher by using a radio equipped with a telephone touch-tone pad. The train radio transmits to and receives from the nearest base station radio that communicates with the dispatcher over wire line circuits. All activity associated with the dispatcher's console is logged through a call management system that identifies the time and length of incoming and outgoing calls.

The rulebook and timetable, in effect at the time of the accident, required that in an emergency, a crewmember touch the number "9," say the word "emergency" three times, and transmit the emergency message. When the dispatcher's receiver receives the call, the console makes an audible noise to alert the dispatcher and displays the message "EMERGENCY." "EMERGENCY" is also displayed against a red background on the chief dispatcher's console. At the same time, the wayside radio base station voting system[9] is disabled, allowing all wayside dispatcher radio stations within range of the calling radio to acknowledge the emergency call.

For unknown reasons, the transmitter board in the Lugoff base station radio failed, and it was impossible for the dispatcher to talk to the traincrew from the nearest base station. Both locomotives had an appropriate radio for signalling. According to postaccident tests, both radios were operating properly.

Operations

The train 82 operations crew consisted of an engineer, a qualifying engineer, a fireman, a conductor, and two assistant conductors. The crew went on duty at their home terminal in Jacksonville at 10:45 p.m. on July 30, 1991, and had been properly rested under the Hours of Service Act. The normal terminus for the crew was Southern Pines, North Carolina.

The accident occurred in the Hamlet Subdivision of the Florence Division. This division extends from Burroughs, Georgia, to Richmond, Virginia. The largest community north of Lugoff is Camden, which, according to the CSXT timetable, is 3.8 miles away. Each day at Lugoff, two freight trains, two Amtrak passenger trains, and two local switcher trains, which total about 5 million gross tons of traffic annually, travel the main track.

A CSXT local switching crew used the Orlon crossover switch about 17 hours before the accident. Another CSXT local switching crew used the crossover to put nine hopper cars on the DuPont siding about 5 hours before the accident. No trains travelled over the main track at the

---

[9]A radio system capable of determining (voting) which base station is receiving the highest strength signal. The system disconnects all the other base stations.

Orlon crossover after these cars were placed on the siding. Neither switching crew reported any difficulty with the switch operation.

The engineer, the qualifying engineer, and the fireman on train 82 took turns operating that train. The engineer took charge of the train in Columbia, South Carolina, and was operating it at the time of the accident. The qualifying engineer was observing from the left seat in the front locomotive unit. He said that when he operated the train, he had no difficulty controlling it with the air brakes. When the accident occurred, the fireman was in the 13th car.

When on the CSXT system, Amtrak crews are subject to both the Amtrak *Manual of Instruction for Transportation Department Employees* and the CSXT *Operating Rule Book* of April 7, 1991. The CSXT timetable in effect when train 82 derailed did not explain the operation of the emergency radio system. This information was issued in a Florence Division superintendent's bulletin on January 1, 1991:

> Emergency radio call-in procedures. When an emergency arises as defined in Rule 514, the following procedure will be used to initiate an emergency call in to the train dispatcher:
>
> 1. Select appropriate train dispatcher channel....
> 2. An answer-back tone will not be heard.
> 3. During the next 20 seconds, the radio is directed onto the train dispatcher's monitor speaker, and the employee will immediately broadcast his emergency message, in accordance with Rule 415, identifying:
>
> (A) transmitting unit (train identification or title and name),
> (B) precise location,
> (C) specific train dispatcher console (several may be coded in), and
> (D) nature of emergency.
>
> 4. When call number 9 has been transmitted, an emergency call indication will appear and remain on the train dispatcher's console until he acknowledges the call in.

The instructions expired on March 31, 1991, and were inadvertently not included in the operating rules or reissued in another superintendent's bulletin. The crew of train 82 initiated the emergency call by pressing "9," as directed by the operating rules.

Meteorological

According to the National Weather Service, fog was noted in the area near Columbia. The accident happened about 35 miles north in Lugoff. Both the engineer and the qualifying engineer reported a light fog and mist in the Lugoff area but said that their visibility was not impaired.

Medical and Toxicological Information

Fatalities.--All eight passengers who died were in the last two coaches and died from multiple injuries. One of the eight died 29 days after the accident.

Injuries.--Ninety-one passengers and 12 OBS crewmembers were taken to three area hospitals for treatment. Twenty-five passengers received routine medical examinations. The 12 OBS crewmembers were treated and released. Fifty-one passengers were treated for minor lacerations, bruises, and abrasions from being thrown inside the cars during the derailment. Fifteen were admitted, including the passenger who died 29 days later. The hospitalized passengers had sustained fractured extremities, internal injuries, and severe lacerations.

Toxicology.--Eight hours 29 minutes after the accident, the Florence Division manager had blood and urine specimens taken from the six operating crewmembers. The specimens were tested by Compu Chem Laboratories, Inc., a Department of Health and Human Services-approved laboratory in North Carolina. The laboratory reported negative test results for drugs and alcohol.

After an accident, according to CSXT policy, the division manager or his representative is to call the operating practices department of the dispatch center in Jacksonville to determine whether mandatory testing is necessary. If it is, the division manager is to designate a supervisor to obtain the specimens. All CSXT supervisors who supervise employees subject to the Hours of Service Act receive approximately 4 hours of training on toxicological testing and a 10-page booklet that explains the procedure and when it is to be used.

Under FRA regulations, whenever a passenger is killed in an accident, the railroad must obtain blood and urine specimens from all employees who are directly involved in the accident and subject to the Hours of Service Act. The regulations do not prescribe a time limit but do specify that the railroad should make every reasonable effort to ensure that the specimens are collected "as soon as possible." Employees who are to be tested are not to be inhibited from duties necessary to preserve life or property immediately after an accident; "however, where practical, the railroad shall utilize other employees to perform such duties." The FRA has monitored the time of postaccident toxicological testing throughout the industry and found that the average time for specimen collection is 5 hours 15 minutes.

Survival Aspects

Postaccident Response of Conductor and OBS Crew.--Because the safety of the passengers is their primary responsibility, the conductor and the chief of the OBS crew responded immediately to the seven injured passengers in the last two cars. Later, the conductor briefed emergency responders about the number of injured people and the consist of the train.

According to the passengers, several OBS crewmembers did not react expeditiously to the emergency, while others began to help immediately.

The train had a public address (PA) system that functioned after the accident. According to both the OBS crewmembers and the passengers, no one used the PA system either to provide information or to seek the service of a medical practitioner, as required by Amtrak rules. When newly hired, the OBS crews receive 4 hours of training on emergency response, including the proper use of the PA system. Amtrak has no mandatory refresher training program for its OBS personnel.

A nurse who was a passenger in the seventh car stated, "I had no idea of the severity of the situation and only wish I could have helped. Please address the training of crewmen and keep passengers informed." The conductor and the OBS crew chief said that they were attending to severely injured passengers, as required by Amtrak rules, and while so occupied, they were unable to use the PA system to give instructions to the passengers or other OBS crewmembers.

The OBS crewmembers and the passengers in the front section of the train stated that the passengers were not informed about why they were stopped for so long or that the train was derailed. These OBS crewmembers did not advise the passengers over the PA system, as required by Amtrak rules, about the length of the delay or other means of travel for a long period of time. Passengers in the fourth car stated that it was nearly 2 hours before they were told what had happened and that it was almost another 1 1/2 hours before they were instructed to leave the train.

According to the Amtrak *Manual of Instruction for Transportation Department Employees*, the purpose of the PA system is to convey information to passengers. The manual states that the welfare of the passengers is "of the foremost importance." OBS employees, the manual also states, are "often the only Amtrak representative[s] close by in time of need [and] are looked upon for leadership in unforeseen and emergency situations." The manual directs that:

> When train service is interrupted or when an unusual or serious delay occurs, on-board service employees will obtain necessary information from the conductor to see that passengers are fully informed as to the probable delay or rerouting of trains, and are given every assistance possible in making emergency arrangements for completion of the trip. When additional information is received, passengers must be promptly advised.

Another Amtrak publication, *General Rules/Manuals of Service Instructions for On Board Service Employees,* also makes some of the same points. It states that OBS employees are to advise passengers in procedures to follow in an emergency and that:

> When a medical emergency arises, and while first aid is being administered, a member of the crew should use the public address

system to solicit the aid of a medical practitioner, such as a nurse, doctor, or paramedic.

Emergency Response.--At 5:12 a.m., the CSXT assistant chief dispatcher telephoned the KCEMS and said, "All we know is we've derailed right out of Lugoff headed toward Camden with a bunch of cars turned over and people hurt." When asked for a phone number where he could be reached, he gave the wrong number. The KCEMS called the Kershaw County sheriff's dispatcher (KCSD) for help in locating the accident site. After attempting to contact the CSXT dispatcher, the KCSD sent two deputies at 5:18 a.m.[10] to search for the train. At 5:23 a.m., the KCSD called the KCEMS and said that she had received a call that the train was at the Lugoff crossover. She asked the KCEMS dispatcher whether he was familiar with the location. He was not.

After searching three road crossings, the deputy in Lugoff heard the DuPont plant guard announce a "train on the tracks behind DuPont" on the countywide radio. At 5:24 a.m., the deputy arrived at the DuPont plant and radioed the KCSD that the train was near the DuPont plant.

At 5:33 a.m., the emergency medical services responded to the site. About 5:40 a.m., a KCEMS supervisor and three ambulances arrived. Triage was performed. A command post and a medical treatment area were immediately established near the last coach. A staging area for emergency vehicles and buses was established at the DuPont parking lot. About 5:50 a.m., the KCEMS supervisor notified the Kershaw County Medical Hospital to expect a high number of patients. The hospital activated its disaster plan and called in 100 day-shift employees and volunteers. One doctor went to the accident site. Two hospitals in Columbia also received patients. By 9 a.m., all injured passengers had been taken to hospitals. The rescue operation continued until 11:15 a.m. when the last passengers were taken by bus to the evacuation center or other destinations. At noon, the emergency preparedness director turned the site over to the CSXT.

Disaster Preparedness.--According to the Kershaw County emergency preparedness director, the county disaster plan was put into effect at 6 a.m. and mobilized all fire, rescue, and disaster assistance resources within the county. The CSXT dispatcher notified the KCEMS of the derailment because the CSXT had listed the KCEMS as the primary emergency response agency. However, according to the Kershaw County Sheriff's Department, it was the primary agency.

According to the Florence Division manager, the CSXT had held hazardous-materials drills and provided hands-on training within the Florence Division. However, no other types of simulated disaster drill had been performed by the CSXT or Amtrak with the local fire departments.

---

[10]All times that refer to the actions of the KCSD are estimated.

Tests and Research

Speed Indicator Test.--Amtrak tested the locomotive unit 403 speed indicator, the speedometer, to determine whether it was properly calibrated. It displayed a speed of 80 mph when the actual speed of the train was 79 mph. To comply with CFR 229.117, locomotive speed indicators are to be accurate within plus or minus 5 mph at speeds above 30 mph.

Equipment Inspection.--On July 31, 1991, after the accident, Safety Board investigators conducted an initial terminal air-brake test on the train 82 locomotives and the first 12 cars, which had not derailed. The test revealed that the tread brakes on the L-3 wheel of car 25055 and on the R-2 and -4 wheels of car 25056 were without brake shoe pressure. The brake shoe on the L-3 wheel of car 25018 was not flush against the wheel. On the left side of car 1230, the mounted brake cylinder piston on the A truck would not release without assistance. The rest of the air-brake system functioned as designed.

The section of the train that had not derailed arrived at the Amtrak Ivy City shop in Washington, D.C., 1 day after the accident. A mechanical pit inspection was performed that day. No significant defects were found during this inspection.

Derailed Car Inspection.--When the last six cars were rerailed on site, they were inspected for damage. The brakes were tested, and they functioned. No evidence was found to indicate that defects existed before the accident. Several air-brake valves leaked.

Sleeper car 2446, the northernmost car to derail, was examined at the CSXT Hamlet car repair shop and at the Amtrak Ivy City shop. The car was built in 1950 by the Budd Company, Inc., (now Transit America Inc.). Amtrak rated the maximum speed of the car at 110 mph on the Northeast Corridor. The car was rebuilt in 1981 and overhauled in 1987, and the brake system was converted to a 26C brake system in 1989. The original rubber side bearings of the car were replaced with semi-elliptical, or spring, bearings in 1981. The Budd Company specified the clearance between a car body and the top of a side bearing wear plate on a new truck as 0 to 1/32 inch, a distance that Amtrak considered to be "constant contact." The clearance between the truck and car side bearings on the A-end truck was 1/16 inch on the right side and 1/8 inch on the left side.

At Hamlet, the car body was lifted off its trucks. Although only the trailing truck of the car had derailed, the car was examined because it was the first derailed car. Investigators noted marks around the A-end coupler, a gouge out of the flange, and a batter mark on the R-3 wheel tread. Wheel wear, derailment damage, and side bearing wear were noted.

According to Transit America, lateral roll motion between cars is negligible. Any longitudinal rocking motion between cars must be passed through the drawbar and its cushioning devices. Transit America added that because of this and the flexibility of the stainless steel car body, little, if any, torsional movement is transferred between passenger cars.

Radio Test.--On July 31, 1991, after replacing a defective transmitter board at the Lugoff base station, the Safety Board performed a functional radio test on locomotive unit 403 to reach Jacksonville through Cayce Yard. The test indicated that the radio transmitted and received properly from MPs S349 to S308.

Switch Examination at Safety Board Materials Laboratory.--Some of the switch stand components were examined at the Safety Board materials laboratory. These included the broken cross pin, the spindle, the crank, the connecting rod, the connecting rod bolt, and the safety plate. The cross pin was fractured at a point approximately in line with the inside of the square hole in the crank. Both pieces of the pin were heavily corroded. Cleaning of the cross pin pieces revealed that the corrosion was greater on the piece that had been buried in the ballast. The fracture contained broad crack arrest positions, ratchet marks, and a rougher portion, all consistent with reverse bending fatigue cracking (from repeated back-and-forth bending stresses).

The amount of rotational free play between the spindle and the crank was compared with a cross pin inserted and without a cross pin inserted. The comparison indicated that the cross pin would have been transmitting at least some rotational load from the spindle to the crank.

Investigators reattached the connecting rod to the crank (see figure 7) and duplicated the switch connection that existed at MP S329.6. They found that after the connecting rod was attached as it had been before the accident, it could be manually separated from the crank.

The bolt that connected the connecting rod to the number 1 head rod should have been secured by a cotter pin. Instead, it was secured by a nail. A cotter pin was also missing from the bolt that fastened the head rod to the left-hand switch clip.

The section of safety plate that was directly below the spindle was at its proper depth; however, the section that was below the lug end of the crank was bent downward slightly. (See figures 5, 6, and 7.) With the crank resting on the safety plate, about 1.5 inches of the spindle was still inserted into the crank.

Further inspection of the disassembled switch stand revealed that more shims[11] were in place on the north side than on the south side of the switch stand. The retaining bolt on the shims on the north side did not have a nut. The threads on the bolt showed no signs that a nut had recently been on the bolt. No broken gear teeth were observed. The crank was found to have a 3/8-inch longer throw than permitted by the CSXT standards.

---

[11]Shims in the switch stand are used to adjust the movement of the connecting rod.

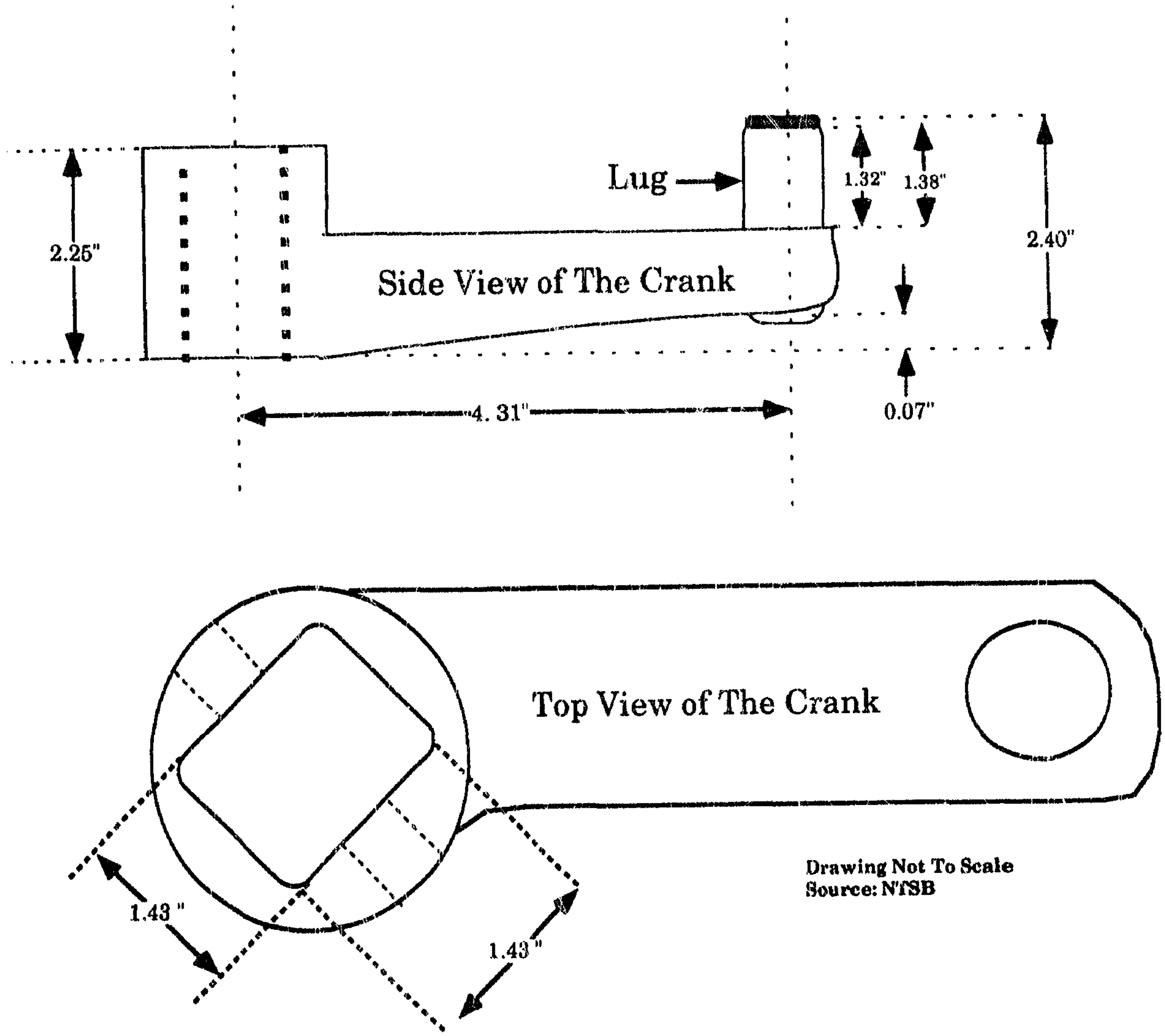


Figure 7.--Crank and connecting rod.

Other Information

Event Recorders.--The Safety Board reviewed the tapes from the train recording media, and the train was operating at the authorized FRA class 4 track speed of 80 mph at the time of the accident.

FRA Inspections.--Following the accident, the FRA conducted a nationwide survey of the Bethlehem 51-A type switch stands. The FRA survey noted that many carriers use the Bethlehem 51-A switch stands on the main track and that these carriers have not had a problem with the under-switch-stand security.

The FRA also issued a technical bulletin (TB-91-04) after this accident on the subject of switch stand safety to all regional directors of safety, track inspectors, and signal and train control inspectors. The bulletin identifies the component attachment beneath switch stands, the mechanical linkage between the switch points and the switch stand, and the uniform classification of defects.

In 1987, the FRA conducted a routine assessment of the CSXT Baltimore Division and Pittsburgh Division, and the assessment results were sent to the other FRA regions. During the assessment, the FRA noted deficiencies in the CSXT supervision of track and switch inspections, in the maintenance of turnouts, in the quality of turnout inspections, and in the reporting and documentation of observations. The FRA recommended that the CSXT management institute separate reporting forms for turnouts and ensure the CSXT engineering standards, as well as the FRA track safety standards, are met. The FRA further recommended that the CSXT train its personnel to inspect or supervise the inspection and repair process, to spot check inspections, and to review the size of track inspectors' territories and of local section maintenance forces to determine whether the numbers are appropriate.

After the FRA assessment, according to the CSXT, the CSXT established an annual training program in which 1 day of the instruction time is allotted to FRA standards, including switch inspection. CSXT personnel who are to be FRA-qualified are required to attend these classes. The CSXT also implemented training in maintenance procedures and provided classes for track inspectors and supervisors. It continued to use the same engineering staff to monitor inspections but assigned an assistant roadmaster from the engineering staff to accompany the track/switch inspectors during inspections. This assignment was made to improve the accuracy in the reports of anomalies and to ensure that inspections were done as frequently as required. The CSXT did not change the size of its territories or its work force, but did evaluate a new standard turnout report.

According to the CSXT, its maintenance-of-way employees are covered by various agreements that dictate their titles and the work rules. Territories are sized to fit the particular situation, and employees with different titles inspect different parts of CSXT track. When asked whether the time required for switch inspection in a given territory is considered, the CSXT replied that the territory size is evaluated and all factors are considered that affect the inspection time which is required in a territory.

The FRA conducted a follow-up investigation and found that the CSXT had significantly increased the training it was giving to employees and supervisors. The followup also revealed that the maintenance and the inspections had improved notably and that supervisors were monitoring the work.

CSXT Postaccident Actions.--During the Safety Board accident investigation, the CSXT updated its rule book to explain the operation of the emergency radio system. The CSXT also corrected the violations (broken/missing pin, missing cotter key, and broken padlock) that the FRA had noted in the postaccident investigation of the Florence Division.

The CSXT has replaced the crossover switch and the switch machine at the accident site. The CSXT has put a T-21 mechanical switch machine,[12] which does not have a lug that can separate from the throw rod, in the main switch. It has also corrected the cross level deficiencies on the track. Between July 31 and August 12, 1991, the CSXT found an additional 31 cotter pin defects and corrected them. At other locations, it has replaced the cross pins in the 51-A switches with harder alloy pins and inspected the safety plates.

ANALYSIS

General

The Safety Board examined the train operation, the signal system, the weather, the design of the switch stand, and the passenger train equipment. Based on the available evidence, none of these factors caused or contributed to the accident.

Train Operation.--After reviewing the event recorder tapes, the transcripts of the operating crew interviews, and the statements of the crew during depositions, the Safety Board determined that the operation of the train did not contribute to the accident. The operating crewmembers were qualified to perform the duties to which they were assigned.

Signal System.--The postaccident inspection and testing of the signal system between the north end of Lugoff siding and the south end of Camden siding demonstrated that the signals operated as designed.

---

[12]A manually operated switch machine that locks the switch points in position through a ratchet mechanism drive. Its components, such as the point detector, the switch circuit controller, and the locking mechanism, are in one locked housing.

Weather.--The National Weather Service reported reduced visibility because of fog in the Columbia area; however, the Safety Board found that the fog did not affect the engineer's ability to see the track or the signals.

Switch Stand.--The Bethlehem Steel 51-A New Century switch stand functioned as designed.

Passenger Equipment.--Although no evidence of prior equipment defects or of prior wheel lift problems existed, the Safety Board examined the equipment and considered the possibility that wheel lift may have occurred on car 2446, which may have been the first car to derail. Wheel lift occurs when the wheel of a train rises above the rail. Body roll and truck hunting[13] were the two factors, related to the possibility of wheel lift, that were examined.

For wheel lift to occur, causing the wheel flange to rise above the rail head, the suspension system of a car must be fully compressed. Transit America, the designer of the car, stated that to fully compress the suspension system of car 2446, the roof rail of car 2446 would have had to lean 15 inches, which would have happened only after extreme body roll. Statements from witnesses riding in the car at the time of derailment do not indicate that the car experienced extreme body roll. If the car had experienced significant lean, it would not have any side bearing clearance on one side. Postaccident inspection of the car showed that its derailed truck had side bearing clearance of 1/16 inch on one side and 1/8 inch on the other. Amtrak and Transit America representatives testified that such wear was normal. The Safety Board also looked for evidence of truck hunting. If truck hunting had been a factor in the derailment, evidence of unusual wheel wear would have been found.

The Accident

As train 82 travelled north, it passed over Lachicotte Road crossing and then over a main track switch at MP S329.6. Both locomotives and 12 of the 18 rail cars passed over the crossing and the switch without problem. As the 13th car crossed the switch, the Safety Board believes the connecting rod of the switch disengaged, which allowed the switch points to open. Because the points were open, the 13th through 18th cars derailed.

Opening of Switch Points

Despite the missing cross pin, the switch operated for a period of time before the accident, as demonstrated by the rub marks on the safety plate caused by rotational contact with the crank. As the first part of the train crossed the switch, the switch points remained in their proper position. The irregular track surface and the normal motion of the track structure and the switch from the passage of the train caused the inadequately connected connecting rod and crank

---

[13]Truck hunting is a lateral instability of the car truck at high speeds when the wheels shift from side to side on the track.

to separate. After separation, nothing was present to keep the switch points closed, and the train-induced motion caused them to open.

The crank was lower than it should have been because the missing cross pin allowed the crank to drop down on the spindle to the safety plate. The safety plate performed its intended function of keeping the spindle and crank engaged, although the cross pin was missing. If a normal amount of ballast had been in the crib, the switch connecting rod would have been positioned farther down the crank lug. However, the ballast was high enough that the connecting rod had been pushed up and was rubbing the underside of the switch stand.

Because the connecting rod was higher than it should have been and the crank was lower than it should have been, the lug end of the crank and the connecting rod were minimally engaged. The motion, induced by the train, was intensified by the cross level deficiency of the track, which caused the connecting rod and crank to overcome the minimal connection and separate as train 82 passed over the switch.

The Safety Board concludes that the cross pin had been missing for some time before the accident because one piece of the cross pin was found under 3 inches of ballast and debris, another piece of the cross pin remained on top of the ballast, and both pieces were heavily corroded.

Adequacy of Switch Inspections

On the day before the accident, the trackman aligned the main track switch so that he could pass over it in the on-track hi-rail inspection vehicle. He visually inspected the switch as he aligned it and as he returned it to its normal position.

In the weeks before the accident, the switch had undergone several visual inspections (at least 8 per month, which was considered the CSXT standard) and the FRA-required monthly inspections. The inspectors, who included the roadmaster, a track inspector, and the signal supervisor, had independently inspected the switch. None of these switch inspections noted the broken cross pin, the cross level deficiencies, or the nail used instead of the cotter pin. The inspectors could have and should have seen the switch deficiencies during a normal inspection and, with appropriate action, could have prevented the accident.

After reconstructing the switch and stand to duplicate the conditions of the accident, the Safety Board found that the connecting rod could be manually separated from the crank. The bolt that connected the connecting rod to the number 1 head rod should have been secured by a cotter pin. Instead, it was secured by a nail. A cotter pin was also missing from the bolt that fastened the head rod to the left-hand switch clip, which also lacked a cotter pin. The section of the safety plate that was directly below the spindle was at the proper depth; however, the section that was below the lug end of the crank was bent downward slightly. About 1.5 inches of the spindle was still inserted into the crank, which rested on the safety plate.

When the Safety Board inspected the switch after the accident, the numerous deficiencies found in the switch indicated that the inspections and maintenance were inadequate. Further inspection of the switch stand revealed that more shims were in place on the north side of the switch stand than on the south side. The retaining bolt on the shims on the north side did not have a nut. The threads on the bolt showed no signs that a nut had recently been on the bolt.

The combination of extra shim packs that were used within the switch stand mechanism indicated excessive adjustment requirements for the switch stand. The need for additional shims to adjust the switch points, by the use of cut plate shims behind the switch point clips and switch stand, indicated a pattern of more than normal wear or damage to the switch and switch stand.

The additional shims between the switch point and switch point clip were evidence of a quick-fix switch maintenance procedure because the switch is not designed for adjustment in that area. Also, the switch crank had been replaced. The replacement crank, which had a 3/8-inch longer throw than the CSXT standard, indicated previous repairs had been made to the switch to provide adjustment for operation.

No documentation emerged during the accident investigation that the switch had been improperly run through by a train before the accident or damaged when the quick-fix repair was made. However, the longer crank, the bent safety plate, and the extra shims in the switch stand mechanism and on the switch point clips indicate that the switch had required and received maintenance as a result of either damage or excessive wear. Despite the extensive maintenance, Safety Board investigators after the accident discovered a broken and corroded cross pin, excess ballast that fouled the connecting rod, and cross level deficiencies on the main track at the switch.

Although the inspectors knew about the excess ballast, they did not remove it. This excess ballast made the switch harder to throw and prevented a true adjustment because the ballast underneath the connecting rod kept the rod in a raised position.

Although the track inspector, the trackman, and the roadmaster were sufficiently trained and experienced to do the inspections and maintenance, the condition of the switch indicated that the CSXT and FRA procedures had not been followed. If the switch had been inspected and maintained to comply with the CSXT and the FRA requirements, such as the requirement that the connecting rod must be securely fastened, the worn, broken, fouled, and missing parts would have been noted and corrected, and the accident would probably not have occurred. These deficiencies indicate that the maintenance and inspection practices of the CSXT on this roadmaster's territory before the accident were inadequate and ineffective. The roadmaster and the track inspectors stated that they were not doing the track and switch inspections as required because the track surface repairs and other maintenance needs that they found during the day did not allow them enough time to do that work and to complete the required inspection schedule.

The Safety Board investigators also found that the CSXT inspection process lacked an adequate documentation procedure. The CSXT track inspectors were not required by the CSXT or the FRA to have detailed documentation for each switch that was inspected during monthly inspections. The lack of adequate inspection documentation could have contributed to the failure to detect and correct the problems with the switch. Without adequate records on each switch inspection performed, the CSXT inspectors cannot verify whether an inspection has been made, and an inspector can overlook a developing problem.

The CSXT switch inspections were deficient, and the personnel responsible for the track and switch inspections overlooked easily observable deficiencies, such as the broken cross pin, missing cotter pins, cross level defects, and the excess ballast under the switch connecting rod. The Safety Board determined during the investigation of this accident that the inspections on the Hamlet Subdivision were cursory, did not conform to existing procedures, and were not properly documented. Therefore, the Safety Board believes that the CSXT should review and revise, as necessary, existing practices to ensure that track supervisors review their subordinates' track inspections and that switch inspections are adequately documented.

CSXT Track Inspection Program

The testimony of the roadmaster and track inspector indicated that the inspectors on the Hamlet Subdivision had insufficient time to properly inspect the track and to perform other duties. They testified that they had 25 to 30 switches to examine each day. According to the roadmaster, a switch can be inspected in 10 to 15 minutes if no repairs are needed. The chief engineer of the CSXT track department confirmed the roadmaster's statement that it can take 10 to 15 minutes for a switch inspection, and he added that under certain circumstances, it could take up to 20 minutes. Consequently, inspecting an average of 27.5 switches a day and spending an average of 12.5 minutes on each, an inspector would require 5 hours 44 minutes daily for switch inspection (travel time not included). An inspector also has about 35 miles of track to inspect each day, which requires 2 hours 20 minutes if he drives a hi-rail vehicle at 15 mph. A 15-mph speed is appropriate for main track inspection in the Lugoff area according to the FRA regional track inspector. However, the 2 hours 20 minutes does not allow for slowing to 5 mph, as the CFR requires, when a vehicle crosses switches and track or highway crossings.

A CSXT inspector needs 8 hours 4 minutes each day to inspect switches and track (5 hours 44 minutes and 2 hours 20 minutes, respectively). This time expenditure allows no time for other necessary activities, such as travelling to and from inspection areas, clearing the track for trains, or normal maintenance and repair. Because an inspector must engage in these other activities, the time he can spend on inspections would be depleted accordingly. The roadmaster has an additional important and time-consuming responsibility, checking the quality of the inspections done by the track inspector and the trackman.

Initially, the track inspector stated that he had adequate time to fulfill his inspection requirements and that he could meet the requirements if he did not have anything else to do. He noted, however, that often he had something else to do, such as tamping, track surface smoothing, or other duties that were unknown when he began an inspection trip. Thus, he qualified his earlier statement and said that taking care of maintenance and other duties did not leave him enough time to get his inspections done and that this had been the situation for about 3 or 4 years. He attributed the situation to the elimination of some positions and the reassignment of personnel. He also reported that he did not do a detailed inspection each time he inspected a switch but that the monthly inspections were more detailed and thorough. He added that as long as the switch threw well and the points fitted up, he did not generally check everything. The track inspector's statements that he did not have sufficient time to adequately do his work and that during his inspections, he checked only whether the switch points fitted properly indicate a definite need for an evaluation of his work schedule.

The roadmaster reported that he worked 10- or 11-hour days to complete his duties. Even working these hours, he could not complete the 50 percent of inspections for which he was responsible. The reports for the 3 months before the accident showed that he had done only 4 (7 percent) of the 55 recorded track inspections. His inability to do half of the inspections increased the number that the track inspector and the trackman had to do, and they already had more work than they could manage. The roadmaster stated that although the assigned manpower for his territory had been reduced by half, the time for inspections remained adequate. According to the CSXT, automation and mechanization of the work have compensated for the reduction in the work force.

Postaccident Performance of Amtrak Personnel

Use of Public Address System.--The operating and OBS traincrews did not use the PA system to locate passengers who had any medical expertise. The conductor and the OBS chief were attending to several severely injured passengers; however, the other crewmembers should have used the PA system, as required by Amtrak rules, to give information about the emergency and related instructions to passengers and crew. The use of the PA system is especially important during evacuations at night and in tunnels to prevent passengers from panicking in the darkness.

Amtrak rules currently require personnel to use the PA system to contact medical practitioners, advise passengers in an emergency, or announce delays between stations. Amtrak rules should be amended to require the operating and the OBS traincrews attend refresher training in the use of the PA system during emergencies to locate medical practitioners and to instruct passengers.

First-Aid Training.--According to Amtrak, train crewmembers are responsible for providing first aid until the emergency responders arrive; however, Amtrak rules do not require OBS personnel to be trained in first aid. Furthermore, Amtrak does not currently have a written policy requiring OBS personnel to attend refresher training in first aid or in emergency response procedures. The conductor and the OBS crew chief responded immediately to help the injured passengers. If they had been trained in first aid, their efforts to treat the injured may have been enhanced.

First-aid training should be required for Amtrak conductors and OBS crewmembers to enable them to assist passengers during emergencies. Whether the administration of first aid or cardiopulmonary resuscitation would have been instrumental in saving lives in this accident is not known; however, it may have been helpful. Amtrak operates in some remote areas where emergency responders may not arrive immediately on scene. In those cases, only passengers or crewmembers can provide immediate medical treatment. Therefore, the Safety Board believes that Amtrak should require that all on-board service personnel periodically take training in the emergency operating rules and in first aid, cardiopulmonary resuscitation, and the use of the public address system during train emergencies.

After its investigation of a June 1982 train accident at Gibson, California,[14] the Safety Board issued Safety Recommendations R-83-72 and -73 in July 1983 and asked that Amtrak:

> R-83-72
>
> Include both Amtrak supervisory personnel and on-board service personnel in refresher training programs covering the changes in Amtrak emergency procedures. Arrange with all railroads, over which Amtrak trains are operated, emergency training for traincrew employees qualified for assignment to passenger service.
>
> R-83-73
>
> Extend the training program for on-board service personnel to require them to demonstrate their ability to operate emergency exits and emergency equipment and to perform assigned emergency responsibilities, outlined in the service manual A, in simulated exercises.

Amtrak responded to R-83-72 on September 21, 1983, in a letter that read:

> A refresher training program for all employees who work on board the train is planned for implementation in the late fall of 1983. This program will reinforce material presented in the 1982 emergency and evacuation program, plus provide additional points on handling passengers in emergencies.

In further response on October 12, 1984, Amtrak stated, "A program has been developed to provide refresher training to Amtrak supervisors and on-board service personnel."

---

[14]Railroad Accident Report--*Fire On Board Amtrak Passenger Train No. 11 Coast Starlight, Gibson, California, June 23, 1982* (NTSB/RAR-83-03).

Also, in the October 12, 1984, response, Amtrak referred to R-83-73 and stated that:

> The Amtrak training department has developed and distributed to the field an updated, advanced four-hour course on emergency procedures... The updated program combines standing instructions pertaining to these types of equipment and is also expanded to include the transfer of passengers from a stalled train and evacuation from tunnels....The complete course of four hours uses lecture/discussion and role play techniques to teach proper response to an emergency....

As a result of actions described in the October 12, 1984, response, Safety Recommendations R-83-72 and -73 were classified "Closed--Acceptable Action" on March 26, 1985. Since the Lugoff accident, however, the Safety Board has learned from Amtrak officials that although the programs developed as a result of Safety Recommendations R-83-72 and -73 still exist and courses are offered periodically, employee participation is voluntary and attendance is poor.

The Safety Board is concerned about passenger safety and believes that periodic refresher training in emergency operations for all Amtrak OBS personnel is necessary. During this accident investigation, Amtrak indicated that it would act positively on any recommendation for employee training that would improve passenger safety during emergency situations.

Emergency Response

A deputy sheriff arrived at the accident scene about 20 minutes after the engineer contacted the CSXT dispatcher. Emergency medical personnel arrived 16 minutes after the deputy sheriff. Five occurrences caused the delay (which was no more than 7 minutes) in emergency response: the information about the location of the train was inadequate, the CSXT dispatcher had an out-of-date emergency response telephone list, the CSXT dispatcher gave his phone number incorrectly to the KCEMS, the transmitter board at the Lugoff base station failed, and the CSXT dispatcher used railroad jargon that confused the emergency response personnel.

At 5:07 a.m., the train engineer radioed the Cayce yardmaster about the accident at the "crossover at Lugoff" and radioed at 5:12 a.m. that the accident was at "the lead into the DuPont plant at Lugoff." This information would have enabled emergency response personnel to locate the train because DuPont has only one facility in Lugoff. However, either the Cayce yardmaster or the CSXT assistant chief dispatcher did not convey such specific information to emergency response personnel, and the train was not located until 5:24 a.m. The KCEMS was immediately notified, left at 5:33 a.m., and arrived at the accident scene by 5:40 a.m.

In addition, had the emergency response telephone list been current, the CSXT dispatcher would have called the KCSD, which is the primary communications link, instead of the KCEMS.

Therefore, the Safety Board believes that the CSXT should maintain an up-to-date emergency response telephone list.

Another occurrence that slowed the emergency response was the failure of the transmitter board at the Lugoff base station, which made it impossible for the dispatcher to respond over the Lugoff base radio station. The dispatcher, however, had no indication, or the means to know, that the transmitter had failed because the CSXT had no test system that would notify him of a transmitter failure. If the dispatcher had known about the failure, he could have contacted the train sooner over an adjacent radio station, such as Cayce Yard.

Finally, the engineer accurately described the Lugoff crossover as the accident location to the Cayce Yard personnel, and the CSXT dispatcher monitored the communication. The Safety Board concludes that had new instructions on emergency radio procedures been published in the operating rules or the current timetable, as they should have been, the locomotive crew might have broadcast a more detailed description of the train location and eliminated the confusion and delay. In addition, the CSXT dispatcher used the same term "crossover" when he talked to the emergency response agencies. "Crossover" is railroad jargon for a track structure composed of two or more turnouts that permits the continuous travel of cars from one track to another, but the emergency responders understood the term as a road crossing. After the deputy sheriff was notified, he searched the three Lugoff road crossings instead of proceeding directly to the Lugoff crossover, which added to the confusion and delay. The CSXT should not use railroad jargon when giving directions on accident locations to law enforcement and emergency responders. The Safety Board believes that terminology should be used that can be readily understood by local emergency response personnel when advising them of train locations after an accident.

Timeliness of Toxicological Testing

The main objective of postaccident toxicological testing is to determine whether drugs or alcohol was responsible for or contributed to the cause of an accident; to make such a determination, blood and urine specimens must be taken soon after an accident. Although drug or alcohol use by the train crew was not suspected and no drugs or alcohol was found in the collected postaccident specimens, the Safety Board is unable to determine whether drugs or alcohol was a factor in this accident because of the delay in collecting the specimens.

The time required for the traincrew to perform their postaccident duties was short. About 1 1/2 hours after the accident around 6:30 a.m., the incident commander for the emergency medical services reported that he had sufficient emergency personnel on scene to relieve the traincrew of emergency medical duties. However, the CSXT did not prepare for the specimen collection until 5 hours after the accident and had not completed taking the specimens until 8 hours 29 minutes after the accident. The Safety Board believes that the CSXT should revise its postaccident drug and alcohol testing procedures to ensure timely specimen collection.

To facilitate postaccident toxicological testing, the CSXT distributes a 10-page booklet that contains clear and easy-to-follow testing guidelines that are suitable for use by any company officer. However, only the division manager or his representative has the specific assigned responsibility to call designated officials in Jacksonville to ensure that based on the accident circumstances, mandatory testing is required. Once that requirement has been confirmed, subsequent postaccident specimen collection and testing procedures can be completed by any qualified company officer.

The CSXT should emphasize in its written postaccident toxicological testing guidelines and in its training of company officials, the critical need to obtain postaccident toxicological specimens as soon as possible. The specimen collection process should have taken less time than the 8 hours 29 minutes that was required. Had the division manager given higher priority to postaccident testing and, either immediately before departing for or after arriving at the accident scene, assigned responsibility to another company officer, the process could have begun much sooner. Immediately after an accident, the CSXT should designate a railroad representative who has the single task of ensuring that postaccident toxicological specimen collection is completed.

CONCLUSIONS

Findings

1. The train operation, the signal system, the weather, the design of the switch stand, and the passenger train equipment were not factors in this accident.

2. The switch stand cross pin had fractured and been missing from the spindle and crank for some time before the accident.

3. The CSX Transportation Inc. track maintenance and inspection process was not adequate to detect and correct in a timely manner the problem that existed in the Orlon crossover switch.

4. The Orlon crossover switch was not properly maintained for some time before the accident.

5. The on-board service crewmembers failed to follow appropriate established emergency procedures, such as using the public address system to inform passengers about the emergency and give related instructions.

6. The on-board service crewmembers were not required to attend periodic training in first aid or emergency procedures, such as the use of the public address system to locate passengers who had medical expertise and might have been able to render assistance.

7. Had new instructions on emergency radio procedures been published in the CSX Transportation Inc. timetable, the locomotive crew might have broadcast a more detailed description of the train location and eliminated the confusion and delay.

8. The inability of the dispatcher to respond over the Lugoff base radio station because of the transmitter board failure slowed the emergency response effort.

9. The postaccident drug and alcohol testing was not conducted soon enough after the accident to provide meaningful test results.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this derailment was the opening of the switch points under Amtrak train 82 because of a poorly maintained switch as a result of inadequate track inspections, switch maintenance, and management oversight.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board makes the following recommendations:

--to CSX Transportation Inc.:

> Review and revise, as necessary, existing practices to ensure that track supervisors review their subordinates' track inspections and that switch inspections are adequately documented. (Class II, Priority Action) (R-93-18)
>
> Review and revise, as necessary, manpower schedules for track and switch inspections to ensure that the track and switch standards of the Federal Railroad Administration and the CSX Transportation Inc. can be met. (Class II, Priority Action) (R-93-19)
>
> Maintain an up-to-date emergency response telephone list. (Class II, Priority Action) (R-93-20)
>
> Instruct dispatchers on the use of terminology that can be readily understood by local emergency personnel when advising them of train locations after an accident. (Class II, Priority Action) (R-93-21)

Revise postaccident drug and alcohol testing procedures to ensure timely specimen collection. (Class II, Priority Action) (R-93-22)

--to the National Railroad Passenger Corporation:

Require that all on-board service personnel periodically take training in the emergency operating rules and in first aid, cardiopulmonary resuscitation, and the use of the public address system during train emergencies. (Class II, Priority Action) (R-93-23)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

CARL W. VOGT
Chairman

SUSAN M. COUGHLIN
Vice Chairman

JOHN K. LAUBER
Member

CHRISTOPHER A. HART
Member

JOHN A. HAMMERSCHMIDT
Member

September 13, 1993

APPENDIXES

APPENDIX A

INVESTIGATION AND DEPOSITION

Investigation

The Safety Board was notified of the accident at 8:30 a.m. on July 31, 1991. The Safety Board Chicago field office dispatched a track investigator to the scene, and headquarters dispatched a Member, the investigator-in-charge, and the investigative team, who formed operational, mechanical, track, signal, human performance, and survival factors investigative groups.

Deposition

The Safety Board held a deposition hearing on November 7 and 8, 1991, in Columbia, South Carolina. The hearing participants included the CSXT, the FRA, Amtrak, Bethlehem Steel Corporation, Transit America Inc., the Brotherhood of Locomotive Engineers, the Brotherhood of Maintenance of Way Employees, and Kershaw County.

APPENDIX B

PERSONNEL INFORMATION

Engineer

T. A. Hill, 49, was hired as a fireman on March 23, 1973, by the Seaboard Coast Line. He became a qualified engineer in April 1976; however, because of his low seniority, he functioned mainly in a fireman position. He became an Amtrak employee in August 1986, when Amtrak assumed passenger operations on the territory, and began operating exclusively as an engineer in August 1990. Assigned initially to the extra board, he assumed in April 1991 his current assignment as engineer on train 82 operating between Jacksonville, Florida, and Southern Pines, North Carolina. He operated approximately three round trips each week over the territory during the 11 months before the accident. He also had operated over this territory at other times during his career.

Mr. Hill passed both his last air-brake test and his last CSXT rules exam in 1990. He successfully completed an engineer evaluation on June 18, 1991, and his evaluator commented, "Mr. Hill does a fine job operating trains over his assigned territory." He also passed his efficiency tests of July 17, 1991. No disciplinary action was noted on his record.

Fireman

J. Q. Palmer, 43, was hired as a brakeman on June 1, 1974, by the Baltimore & Ohio Railroad (B & O). He became a fireman in 1979, was promoted to engineer in April 1980, and operated as an engineer until 1984, when he became the United Transportation Union general chairman for the B & O. Because of his occupation in union activities, he functioned only part time as an engineer in 1985 and 1986. Mr. Palmer moved in 1986 to Jacksonville as a manager of labor relations for the CSXT. In September 1987, he left the railroad industry for 3 years and returned when he was hired as a fireman by Amtrak on June 26, 1990. Initially assigned to the extra board, he was assigned to train 82 in April 1991.

Mr. Palmer had not attended an air-brake class since his employment with Amtrak. However, he passed his last CSXT rules exam on January 10, 1991, successfully completed an engineer evaluation, and passed his efficiency tests of July 17, 1991. No disciplinary action was noted on his record.

APPENDIX B

Qualifying Engineer

C. P. Peterson, 53, was hired by the Pennsylvania Railroad as a yard brakeman in 1957. He worked as a brakeman or fireman for five different railroads until 1970, when he was promoted to engineer during his employment with the Chicago and Northwestern Railroad. In April 1973, he joined the Seaboard Coast Line and was promoted to engineer in December 1973. He moved to Amtrak, was promoted to engineer on May 15, 1991, and was then assigned to train 82 to qualify over the territory.

Mr. Peterson successfully completed his last air-brake test on July 11, 1991, a CSXT rules exam on October 13, 1990, an engineer evaluation on June 18, 1991, and his efficiency tests on July 17, 1991. No disciplinary action was noted on his record.

Roadmaster

L. E. Bowers, 45, was hired as a trackman by the Seaboard Coast Line on December 10, 1965. After becoming a machine operator in 1970, he was then promoted several times: to apprentice foreman in 1972; to assistant foreman, foreman, and assistant roadmaster in 1978; and, finally, to roadmaster in 1980. He was the roadmaster over the same basic territory, which covers about 180 miles of main line track, 300 switches, and 2 yards and includes the accident site.

Mr. Bowers became an FRA-qualified track inspector on June 1, 1970. He attended a CSXT-conducted FRA rules review in 1990 and passed his most recent hi-rail and operating rules exam on May 3, 1991.

Track Inspector

J. R. McLain, 47, was hired as a trackman by the Seaboard Coast Line in March 1968. He was promoted to apprentice foreman in March 1969 and to foreman in July 1975.

Mr. McLain became FRA qualified to inspect track in 1972, and each year since, he has taken and passed an operating rules test, which includes FRA track safety standards. He took the last test on May 20, 1991. His immediate supervisor, Roadmaster L.E. Bowers, described his work as high quality. Mr. McLain's work record contains a disciplinary entry in 1980 for entering a block without authority and another entry in 1985 for a train striking a tamping machine, an incident for which he accepted responsibility.

Trackman

Q. A. Martin, 40, was hired as a trackman on an extra gang by the Seaboard Coast Line in December 1969. He has been an apprentice foreman since March 27, 1982. He became FRA qualified to inspect track in 1985, working with Track Inspector J.R. McLain since that qualification. Mr. Martin passed his last operating rules exam in April 1991. His work record contains a disciplinary entry in 1973 for failing to report to work.

APPENDIX C

SILVER STAR CONSIST LIST

	Vehicle No.	Type	Leading End	Type
1	403	F40 PH	F	EMD Phase III
2	257	F40 PH	F	EMD Phase II
3	1230	Baggage	A	Heritage
4	1267	Baggage	B	Heritage
5	1620	Baggage-Dormitory	A	Heritage
6	25018	Coach	B	Amfleet II
7	25011	Coach	B	Amfleet II
8	25056	Coach	B	Amfleet II
9	25055	Coach	B	Amfleet II
10	3118	Lounge (Casimire Pulaski)	A	Heritage
11	2095	Sleeper (Silver Repose)	A	Heritage
12	2455	Sleeper (Elm Grove)	B	Heritage
13	8711	Buffet	A	Heritage
14	8553	Diner	B	Heritage
15	2446*	Sleeper (Cypress Grove)	B	Heritage
16	28004*	Lounge	B	Amfleet II
17	25064*	Coach	B	Amfleet II
18	25060*	Coach	B	Amfleet II
19	25033*	Coach	B	Amfleet II
20	26002*	Coach	B	Amfleet II

*Derailed car.

Cars on Siding from South to North
in Direction of Travel by Amtrak Train

1	NW	11349	A	Empty Hopper
2	NW	167961	B	Empty Hopper
3	NW	94499	B	Empty Hopper
4	NW	14693	B	Empty Hopper
5	NW	92560	B	Empty Hopper
6	NW	119390	B	Empty Hopper
7	BLE	50868	B	Empty Hopper
8	CSXT	432381	B	Loaded Hopper
9	CSXT	224601	B	Empty Hopper

APPENDIX D

RADIO PROCEDURE INSTRUCTIONS

CSXT radio operating rule 415 states:

> An emergency call must be preceded by the word "EMERGENCY" transmitted three times. Such calls must relay essential information and be used only to cover initial reports of derailments, collisions, storms, washouts, fires, obstruction to track or other matters that would cause serious traffic delay, damage to property or injury to employees or the traveling public. All employees must give absolute priority to emergency calls from another station and must refrain from sending any communication, except to answer or aid a station during an emergency.
>
> The station transmitting an emergency message must broadcast the words "EMERGENCY MESSAGE TERMINATED" to advise other stations in the area that normal radio communication may be resumed.

Florence Division timetable radio procedure instructions, in effect at the time of the accident, require the radio operator to select the proper radio channel (section 1006.03) from a table (231) in that section. The table is noted:

> In an emergency, the control station may be reached by initiating a radio call-in on the appropriate channel using 9 as the call-in number. This procedure must be used only for a condition as stated in Rule 415.

Section 1006.04 details initiating a radio call in and describes in item 1 the selection of the appropriate train dispatcher when one of four radio types is used. Item 2 states:

> Within 10 seconds after a call in has been performed, an "Answer-Back" tone would be heard. Wait for the train dispatcher to answer the call. If the "Answer-Back" tone is not heard, the caller should wait for one minute and try again.

APPENDIX E

CHRONOLOGY OF POSTACCIDENT TOXICOLOGICAL TESTING

0501 -- Accident occurred.

0510-0515 -- Florence Division manager was notified of the accident.

0700-0715 -- Florence Division manager arrived on scene.

0800-1000 -- At the accident scene, the Florence Division manager and the Cayce Yard terminal trainmaster discussed the necessity of postaccident testing and the testing criteria and documented the existence of fatalities. Subsequently, the division manager initiated a conference call to operating practice personnel in Jacksonville. It was determined during the call that postaccident criteria had been met and testing would be conducted, and the required procedures were reviewed. By letter of understanding between the CSXT and Amtrak, the CSXT had the responsibility for determining which Amtrak employees were to be tested and for overseeing the procedures.

1000 -- The terminal trainmaster was designated to oversee the specimen collection. Testing was to be conducted on the six-man operating crew of train 82 (the enginecrew as well as a conductor and two assistant conductors). Time was expended to gather the crewmembers who were at both ends of the train.

1100-1110 -- The appropriate crewmembers were en route to Baptist Medical Center in Columbia, which was chosen because of its familiarity with the FRA collection procedures and its proximity to the toxicological testing kits that were stored at Cayce Yard. The terminal trainmaster did not know that another hospital was closer.

1200 -- The crew and terminal trainmaster arrived at the medical center. Because of the emergency room staff's workload, which included three injured passengers from the accident, the tests were delayed.

1230-1330 -- The specimens were collected.

*U.S. G.P.O.:1993-300-644:80010