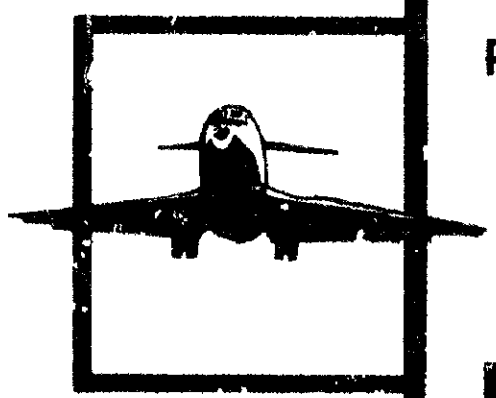
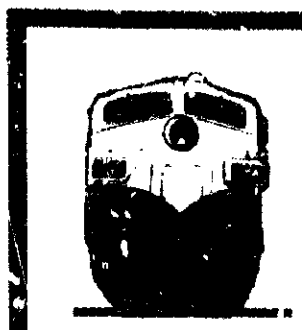
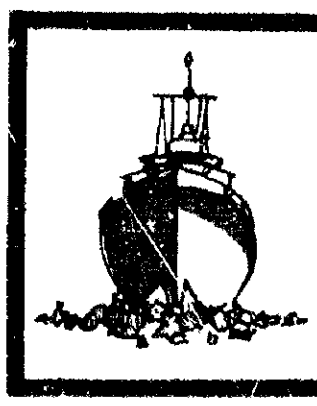
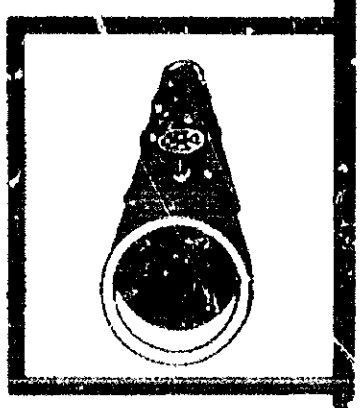
PB85-916303









NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

DERAILMENT OF
AMTRAK TRAIN NO. 81
THE SILVER STAR
ON THE SEABOARD SYSTEM RAILROAD
KITTRELL, NORTH CAROLINA
MARCH 5, 1984

NTSB/RAR-85/03

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB/RAR-85/03	2. Government Accession No. PB85-916303	3. Recipient's Catalog No.
4. Title and Subtitle Railroad Accident Report-- Derailment of Amtrak Train No. 81, The Silver Star, on the Seaboard System Railroad, Kittrell, North Carolina, March 5, 1984		5. Report Date March 5, 1985
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 4107
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Railroad Accident Report March 5, 1984
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

About 6:45 p.m., e.d.t., on March 5, 1984, southbound Amtrak train No. 81, The Silver Star, consisting of 3 locomotive units and 18 cars, derailed 1 locomotive unit and 18 cars while traveling at 79 mph on Seaboard System Railroad track near Kittrell, North Carolina. Of the 274 passengers and 19 crewmembers on board, 52 persons were injured in the accident. Damage was estimated to be $2,536,000.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the overheated No. 1 axle on locomotive unit No. 378. The overheating was due to bearing metal pickup and excessive bearing wear of the pinion end traction motor support bearing because of a substandard finish on the axle journal surface. Contributing to the accident was the lack of an effective system to detect overheated traction motor support bearings before failure. Contributing to the number of injuries was unsecured luggage falling from overhead luggage racks.

17. Key Words overheated axle; traction motor; locomotive; bearing failure; maintenance practices; wayside hot box detector system; journals; luggage restraint; interior car design		18. Distribution Statement This document is available through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 21	22. Price

NTSB Form 1765.2 (Rev. 9/74)

CONTENTS

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: March 5, 1985

DERAILMENT OF AMTRAK TRAIN NO. 81 'THE SILVER STAR ON THE SEABOARD SYSTEM RAILROAD KITTRELL, NORTH CAROLINA MARCH 5, 1984

SYNOPSIS

About 6:45 p.m., e.d.t., on March 5, 1984, southbound Amtrak train No. 81, The Silver Star, consisting of 3 locomotive units and 18 cars, derailed 1 locomotive unit and 18 cars while traveling at 79 mph on Seaboard System Railroad track near Kittrell, North Carolina. Of the 274 passengers and 19 crewmembers on board, 52 persons were injured in the accident. Damage was estimated to be $2,536,000.

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the overheated No. 1 axle on locomotive unit No. 378. The overheating was due to bearing metal pickup and excessive bearing wear of the pinion end traction motor support bearing because of a substandard finish on the axle journal surface. Contributing to the accident was the lack of an effective system to detect overheated traction motor support bearings before failure. Contributing to the number of injuries was unsecured luggage falling from overhead luggage racks.

INVESTIGATION

The Accident

Amtrak train No. 81, The Silver Star, departed Union Station, Washington, D.C., at 2:15 p.m. on March 5, 1984, 30 minutes after its scheduled departure time, for Miami, Florida. The train consisted of 3 Amtrak F40-PH locomotive units, 10 coaches, 3 sleeping cars, 1 combination baggage/dormitory car, 1 baggage car, 1 food service car, 1 dining car, and 1 lounge car. The brakes were tested and the train was inspected by the Washington Terminal (Union Station) inspectors, and no exceptions were taken. The three locomotive units had been inspected and serviced by Amtrak mechanical personnel before being coupled to the train by the Richmond, Fredericksburg and Potomac (RF&P) enginecrews.

Train No. 81 had an uneventful trip from Washington to Richmond, Virginia, where the RF&P traincrew was relieved by a Seaboard System Railroad (SBD) crew. The train departed Richmond at 4:31 p.m. with the engineer in the engineer's seat on the right side of the lead locomotive unit, the fireman in the fireman's seat on the left side of the locomotive unit, the conductor in car No. 9, the flagman in the rear car (car No. 18), and the baggagemaster in car No. 6 (combination baggage/dormitory car).

Train No. 81 stopped at Henderson, North Carolina, (milepost (MP) S-113.8) to pick up and discharge passengers. SBD employees observed the train as it departed Henderson, and a hand signal was given to and acknowledged by the flagman on train No. 81 that no exceptions were taken to its operation.

About 9 miles after leaving Henderson, as train No. 81 passed Kittrell, North Carolina (MP S-122.6), the assistant fire chief of the Kittrell Volunteer Fire Department noticed sparks coming from the wheels of the rear locomotive unit. He did not report this observation to the SBD. Approximately 1 mile after passing Kittrell, the rear locomotive unit and all cars of the train derailed.

The lead locomotive unit stopped at a point 3,998 feet south of MP S-123. The lead locomotive unit and the second unit were not derailed; the third locomotive unit was derailed but remained upright and coupled to the second locomotive unit. The first car in the train (Amcoach No. 21216) was derailed but remained upright and coupled to the third locomotive unit. The second car in the train (Amcoach No. 21014) was derailed and came to rest 903 feet north of the locomotive units and the first car. All of the remaining cars in the train were derailed. (See figure 1.) The engineer notified the chief dispatcher of the derailment by radio and asked for assistance. The traincrew reported inspecting the train en route and said that they neither saw sparks from the train nor observed anything unusual before the derailment.

Injuries to Persons

	Traincrew	Amtrak attendants	Train passengers	Others	Total
Fatal	0	0	0	0	0
Nonfatal	0	11	41	0	52
None	5	3	233	0	241
Total	5	14	274	0	293

Train Information and Damage

The locomotive of train No. 81 consisted of three 3,000 horsepower, F40-PH diesel electric units manufactured by the Electro-Motive Division (EMD) of the General Motors Corporation. The lead locomotive unit was equipped with dual sealed beam headlights; a five-chime, forward-facing horn (whistle); and a bell with an internal pneumatic ringer. In order behind the locomotive, the train consisted of four coaches, a baggage car, a combination baggage/dormitory car, three coaches, a lounge car, two sleeping cars, a dining car, a sleeping car, a lounge car, and three coaches.

The two lead locomotive units (Amtrak Nos. 386 and 382) were undamaged; the third locomotive unit (Amtrak No. 378) was derailed and moderately damaged. The first coach was derailed and moderately damaged; the next nine cars were derailed and extensively damaged. The following eight cars were derailed and received moderate to light damage.

Amtrak and the SBD estimated the total damage to be:

Equipment (locomotive and cars)	$2,417,000
Track	104,000
Signal	15,000
Total	$2,536,000

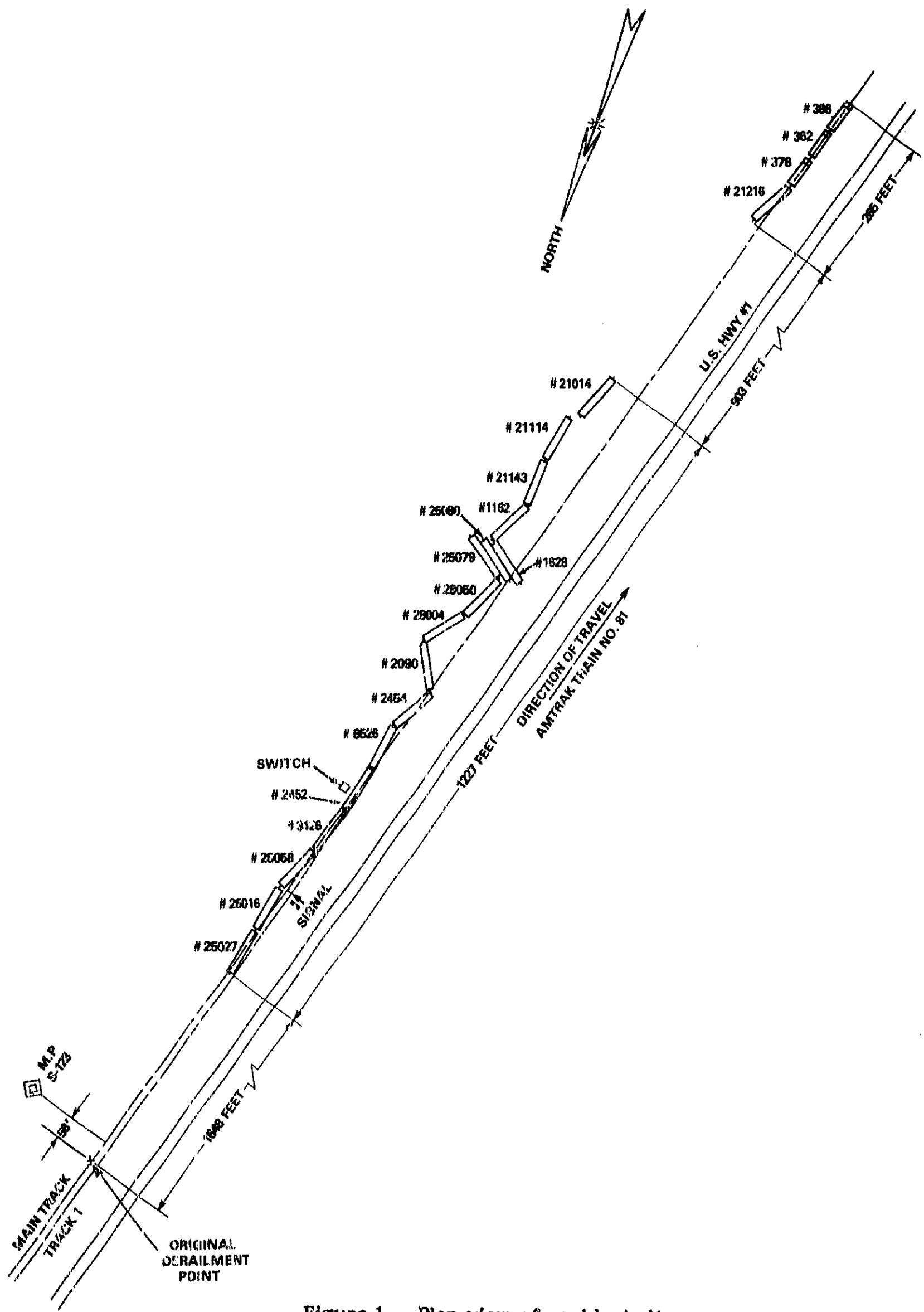


Figure 1.--Plan view of accident site.

Personnel Information

After having been off duty since 6:35 p.m. on March 3, 1984, the engineer and fireman went on duty in Raleigh, North Carolina, at 7:50 a.m. on March 5, 1984, and worked north on train No. 82 to Richmond, where they went off duty at 11:15 a.m. They returned to duty in Richmond for train No. 81 at 3:55 p.m. on March 5, 1984.

After having been off duty since 8:05 a.m. on March 4, 1984, the conductor and flagman went on duty in Raleigh at 7:50 a.m. on March 5, 1984, and worked north on train No. 82 to Richmond, where they went off duty at 11:15 a.m. They returned to duty in Richmond for train No. 81 at 3:55 p.m. on March 5, 1984.

The baggagemaster went on duty at 5:45 a.m. on March 5, 1984, in Hamlet, North Carolina, and worked north on train No. 82 to Richmond, where he went off duty at 11:15 a.m. The baggagemaster returned to duty in Richmond for train No. 81 at 3:55 p.m. on March 5, 1984.

There were 14 Amtrak passenger service personnel on board the train. None of these personnel had responsibility for the operation of the train.

Track Information and Damage

Approaching the derailment site from the north, the track is straight for approximately 2 miles, and the grade is 0.65 percent, descending. The track in the derailment area is constructed of 132-lb. RE continuous welded rail (CWR), which was manufactured and laid new in 1974. In 1983, the track was resurfaced and realigned. The rails rest on 14 1/8-inch by 7 7/8-inch, double-shouldered tieplates and are secured to wood ties with one field side and one gage side cut spike per tie plate. Longitudinal rail movement is restrained by base-applied rail anchors, which are arranged in a box pattern on every other tie. The ties are spaced on 21-inch centers.

The track is surfaced with crushed stone ballast which extends at least 12 inches beyond the ends of the ties. The tie cribs are full and the ballast depth is 8 to 14 inches below the bottoms of the ties. The track is maintained to meet or exceed the Class 4 track safety standards of the Federal Railroad Administration (FRA).

From Kittrell to the derailment site, train No. 81 passed over three railroad/ highway grade crossings. All three of these crossings are four plank crossings with asphalt approaches and asphalt paving between the center planks. Postaccident inspection of these crossings revealed that the north end of the west rail flangeway plank on each crossing had been struck approximately 3 inches inside the gage corner of the rail. The crossing planks were abraded for a distance of 47 to 55 inches on these crossings. (See figure 2.) There were no marks on the grade crossings north of Kittrell. There were wheel flange marks on the spikes and rail anchors 58 feet north of MP S-123. A siding switch located at MP S-123.3 was destroyed in the derailment.

In the vicinity of the general derailment, approximately 4,000 feet of track was damaged and about 1,000 feet was destroyed.

Figure 2.--View of grade crossing north of MP S-123.

Method of Operation

Train movements in the accident area are governed by wayside signal indications, timetable, train orders, bulletins, and special instructions. The maximum authorized speed for passenger trains in the area is 79 mph. The maximum speeds for freight trains varies from 70 mph for piggyback trains to 50 mph for restricted trains.

Overheated journal bearings on SBD trains usually are located by wayside hot box detectors. These detectors use infrared scanners which are located outside the rails. The temperature reading of bearings which pass over the scanners are telemetered to a central location where the information is displayed on a paper tape. When overheated bearings are observed by persons reading the tapes, the information is transmitted to the traincrews by radio.

Meteorological Information

At the time of the accident, the weather was cloudy with light rain and fog, the temperature was 61°, visibility was 4 miles, and the wind was from the south at 10 mph.

Emergency Response

Shortly after the derailment, the SBD and Amtrak train crewmembers circulated among the passengers providing assistance and urging the passengers to remain on board until help arrived. Fire equipment arrived on the scene about 6:55 p.m., and ambulances arrived on the scene about 7:05 p.m. The fire department at Kittrell was notified of the accident by a passing motorist. Other emergency personnel were notified of the accident by the SBD dispatcher. The Vance County Disaster Relief and Assistance plan was used to manage the emergency. The adjoining counties of Wake, Warren, Granville, and Franklin sent fire and rescue equipment to the accident scene.

The rescue teams went through the cars identifying the injured, giving them emergency first aid, and removing them for transportation to local hospitals. During this part of the operation, the uninjured passengers remained on board the train. After the injured passengers were treated, they were removed from the train and carried to ambulances using guide ropes to facilitate movement over the railroad embankment. These guide ropes also served as handrails during the evacuation of the remaining passengers, who were escorted along the guideropes to buses for transportation to the National Guard Armory for temporary shelter and later to local motels for the night. Local school and church buses were used as transportation for the evacuation.

Medical and Pathological Information

Of the 293 persons on board the train, 52 reported injuries; 50 persons, including 11 Amtrak employees, were taken to a hospital in Henderson. The other two injured persons were transported to a hospital in Louisburg, North Carolina. The injuries consisted of cuts and bruises of the head, chest, and shoulders, and back and leg pain. Thirteen persons were hospitalized; 39 persons were treated and released by the hospitals.

Survival Aspects

Some of the passengers stated that during the crash sequence they were thrown from their seats by the deceleration forces. Most of the injured passengers stated that they felt their injuries resulted from luggage which fell from the overhead luggage racks; although some of the seats in the cars rotated on their frames due to broken latches, the seat frames remained intact and securely anchored to the floor.

Tests and Research

Postaccident inspection revealed that the No. 1 axle of the third locomotive unit (Amtrak No. 378) was broken on the pinion (left) end in the traction motor support bearing area. (See figure 3.) The bearing was destroyed, the lubricator wick was burned and charred, and the axle in the bearing area showed evidence of intense heat. The axle was broken at an uneven angle; the short end was 6 7/8 to 8 inches long when measured from the face of the axle gear hub. (See figure 4.) All other support bearings, lubricator wick assemblies, and axles on the locomotive unit were inspected and found to be lubricated and in good condition.

The traction motor/wheel/axle assembly was a D 77B traction motor manufactured by EMD and carried serial No. 83-F-3-1028. Amtrak maintenance records indicated that the traction motor/wheel/axle assembly was assembled from new and reconditioned parts at Amtrak's New Haven, Connecticut, shop and was installed in an overhauled locomotive truck assembly at the facility on February 7, 1984. The overhauled locomotive truck was transported on February 27, 1984, by truck, to Amtrak's Rensselaer, New York, shop, where it was installed on Amtrak No. 378 on March 1, 1984.

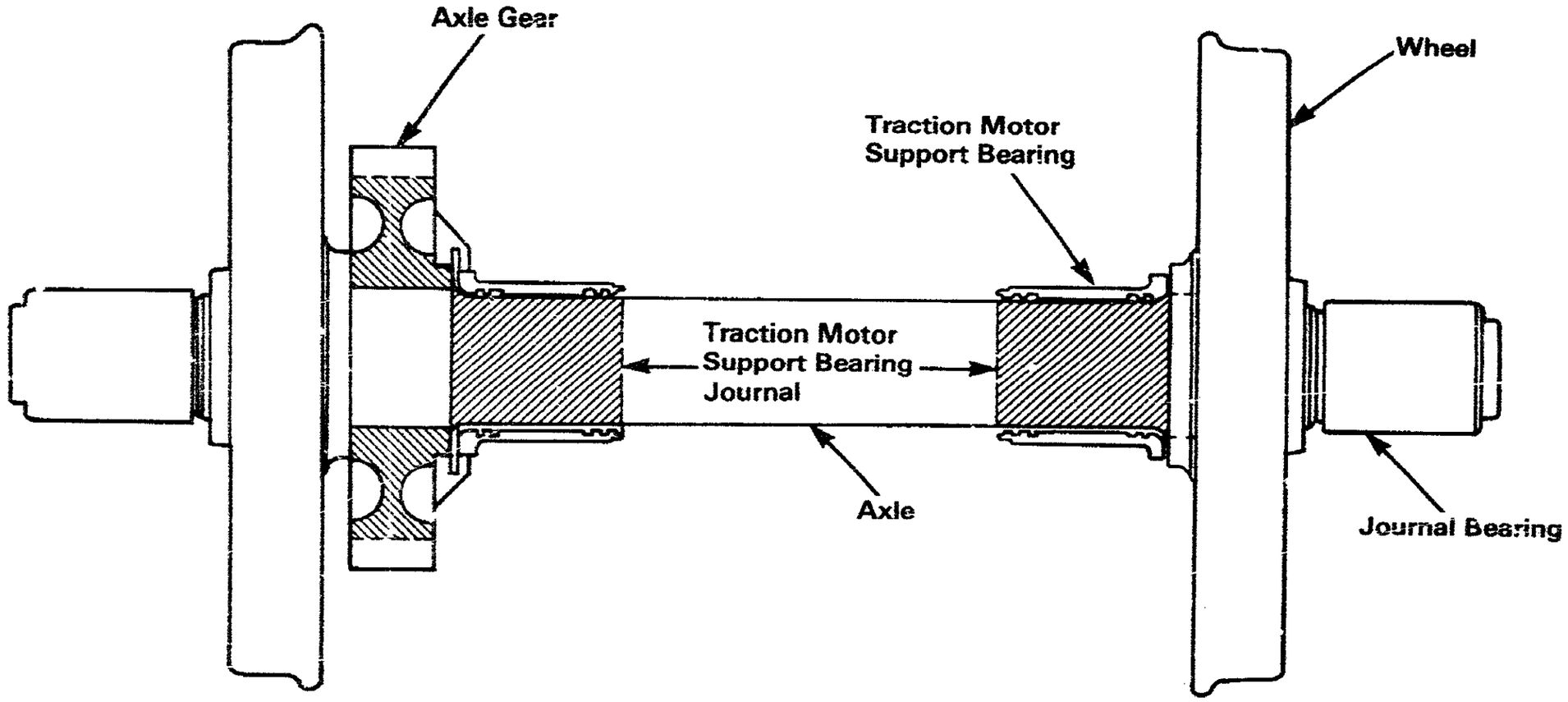


Figure 3.--Locomotive axle assembly showing gear and bearing locations.

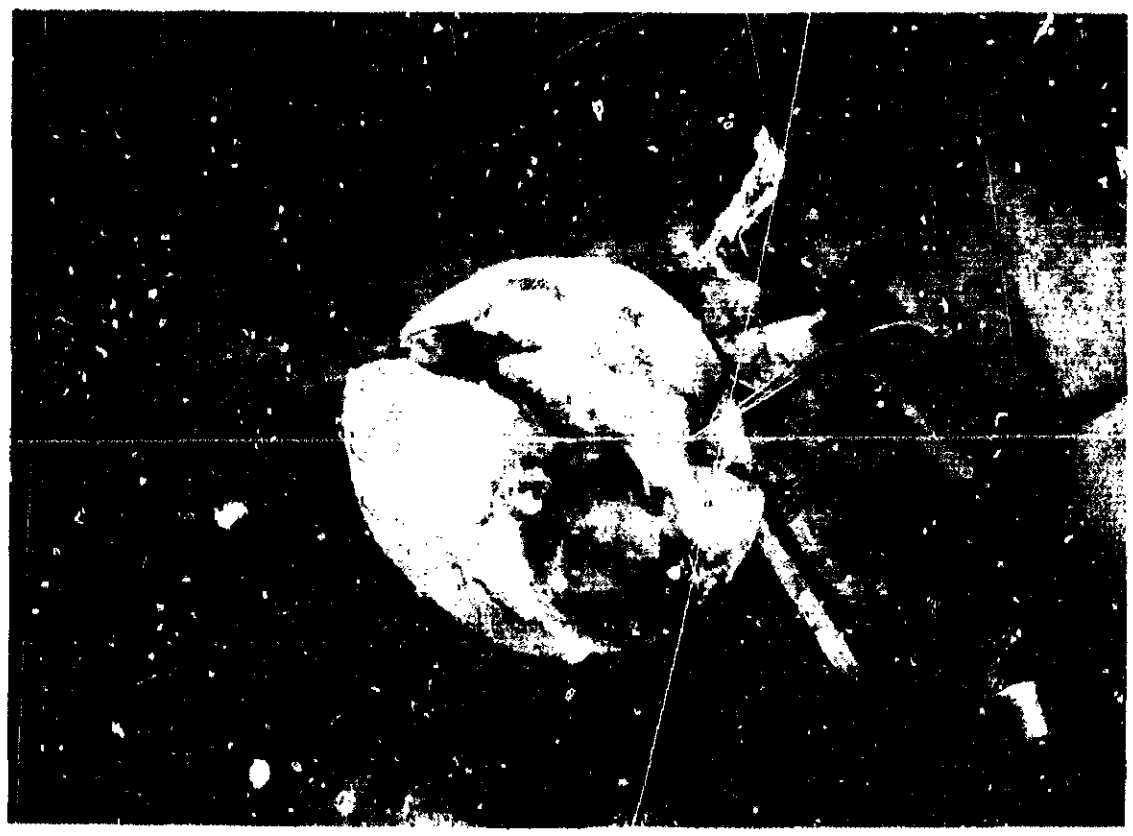


Figure 4.— End view of broken axle from Amtrak locomotive unit No. 378.

Amtrak locomotive unit No. 378 was placed in service in Albany, New York, on March 2, 1984, and operated from Albany to Chicago, Illinois, in train No. 49 on that date. The unit was inspected in Chicago and operated in train No. 50 from Chicago to Washington, D.C., on March 4, 1984. After an inspection in Washington, the unit was operated from Washington to the derailment site in train No. 81 on March 5, 1984. The locomotive unit had traveled approximately 2,000 miles after receiving the overhauled truck.

A check of the facilities and inspection procedures at Rensselaer, Chicago, and Washington, and interviews with the Amtrak personnel involved in the inspection and maintenance of Amtrak locomotive unit No. 378 in the 5 days before the derailment disclosed no irregularities in the inspection and maintenance of locomotive units at these locations.

Amtrak's New Haven maintenance facility employees involved in assembling the traction motor/wheel/axle assembly generally knew the proper procedures and work practices involved. However, while observing assembly procedures at the facility, Safety Board investigators noted that the assemblers were not using any instruments to check the finish of traction motor support bearing journals. The profilometer 1/ in the adjacent wheel and axle shop was used to check the finish on several support bearing journals being assembled. The support bearing finish on these axles varied from 10 to 22 microinches, which was 3 to 15 microinches above the manufacturer's recommended standard and Amtrak's adopted standard of 7 microinches.

1/ An instrument for measuring the smoothness of a finished surface.

The New Haven shop maintenance instruction library contained EMD maintenance instruction MI 1518, revision C, which was dated 1977. This maintenance instruction prescribed a motor support bearing finish of 15 microinches. Although EMD issued revision D to MI 1518 in 1981, the revision was not in the shop library. Revision D of MI 1518 reads as follows:

Motor Support Bearing Area

> The motor support bearing surface finish must be 0.18 microns (7 micro-inches) or finer. If support bearing surface is not at least 0.18 microns (7 micro-inches) grind the surface to 0.64 to 1.27 microns (25 to 50 micro-inches) and then polish to obtain a 0.18 microns (7 micro-inches) or finer surface.

Amtrak had adopted the EMD maintenance instructions on the traction motor assembly as its own maintenance standard.

Safety Board investigators contacted locomotive maintenance personnel of other railroads who disclosed that 15 microinches was the support bearing finish most prevalent in the industry. Investigators learned that there is also industry concern about the adequacy of the present traction motor support bearing design because the higher horsepower, higher speed locomotives develop pinion end bearing loads approximately three times the loading on the commutator end due to the increase in torque applied.

The failed locomotive axle was examined by Safety Board investigators and representatives of the parties to the investigation and was sent to the Association of American Railroads (AAR) Metallurgical Laboratory in Chicago for further testing. The report of the examination and testing by the AAR indicates that the axle exhibited a grossly overheated condition and extensive bearing metal penetration. The original condition of the support bearing surface in the failed end (pinion end) could not be determined due to damage; however, the support bearing area on the other end (commutator end) exhibited out-of-roundness in the support bearing journal surface. The average surface finish on the commutator end support bearing journal was found to be about 30 microinches. (A letter summarizing the results of the AAR metallurgical report is in appendix C.)

En route from Richmond to Kittrell, train No. 81 passed hot box detectors at McKenney, Virginia, and Hagood, North Carolina, which were 76.2 and 39.6 miles north of the derailment site. Neither detector tape showed bearing temperatures higher than normal. The SBD official who interpreted the tapes for the Safety Board stated that the detectors were not designed to scan the area where traction motor support bearings were located. The hot box detector sites also served as locations for dragging equipment detectors. The dragging equipment detectors at these locations were not activated by the passage of train No. 81.

ANALYSIS

The Accident

The train was being operated in accordance with the operating practices of the SBD. The abrasion marks on the railroad grade crossing planks at Kittrell indicate that the locomotive axle broke north of Kittrell allowing the wheels to become out of gage and the

wheel flanges to strike and abrade the grade crossing planks. The fact that there were no marks on grade crossings north of Kittrell indicates that the axle failure probably occurred within 3 miles of the accident site. Wheel flange marks on the spikes and rail anchors indicate that the initial derailment of the No. 1 axle of Amtrak locomotive unit No. 378 occurred 58 feet north of MP S-123. The general derailment occurred when the derailed wheel on the broken axle struck the siding switch at MP S-123.

Bearing Failure Detection

The wayside hot box detector, the primary bearing failure detection system on the SBD railroad, works well with bearings that are located outside the gage of the rails but is not designed for bearings, like the traction motor support bearings, that are between the rails of the track. The secondary means for detecting bearing failure is the traincrew, who observe the train periodically for indications of equipment problems such as fire, smoke, and sparks. The secondary system was ineffective, in this instance, since the traincrew did not discover the presence of the overheated traction motor support bearing. A third means for detecting bearing failure is SBD employees observing trains as they pass. When train No. 81 received this inspection at Henderson, 9 miles from the accident site, no exceptions were taken to the train as it passed. The overheating and subsequent failure of the traction motor support bearing was not detected by any of these procedures because the bearing failure was not detectable at the time the procedures were employed. The traincrew had no way of knowing about the abrasions on the grade crossings at and south of Kittrell and the observation of sparks coming from the train by the firefighter in Kittrell.

As a result of an accident in 1978 caused by an undetected overheated traction motor support bearing, 2/ the Safety Board issued Safety Recommendation R-78-56 on September 27, 1978, recommending that the FRA:

> Develop a method that will automatically detect the failure of a locomotive unit truck or any of its components, independent of crew observation.

The FRA replied on February 2, 1979, that the cost of inservice testing was too prohibitive for daily railroad use and that the technical level of sophistication necessary to effectively operate inservice testing equipment does not lend itself to large-scale application. Additionally, on May 22, 1979, the FRA wrote that in view of the extremely low accident rate directly attributable to defective mechanical and electrical locomotive equipment, the FRA does not consider the research and development of automatic devices for the detection of locomotive unit truck or component defects necessary. Safety recommendation R-78-56 was later classified as "Closed--Unacceptable Action."

Amtrak presently has an onboard hot bearing detection system on the newer passenger cars in its fleet. This system monitors bearing temperature and gives a warning to train personnel when a passenger car bearing becomes overheated. A similar system should be installed on Amtrak locomotive units.

2/ Railroad Accident Report--"Derailment of Autotrain No. 4 on Seaboard Coastline Railroad, Florence, South Carolina, February 24, 1978" (NTSB/RAR-84/05--Supersedes NTSB-RAR-78-6).

Emergency Response

The emergency response was timely, and the treatment of the injured was efficient and effective. The evacuation and shelter operation was well planned and executed.

Injury Causation

Most of the injuries to passengers and crew occurred from being thrown about in the car and because of impacts from luggage falling from the overhead luggage racks.

As a result of its investigation of a passenger train accident in 1970 involving similar passenger injuries, 3/ the Safety Board issued Safety Recommendation R-71-6 on February 3, 1971, recommending that the FRA:

> Institute immediate regulations requiring the equipment of all future, new and rebuilt, passenger cars with secured seats and luggage retention devices.

On January 5, 1976, the FRA replied that it was necessary to complete a study and subsequent evaluation before any determination could be made as to regulations. To date, the FRA has not issued any regulations on the strength of passenger seats or on luggage restraints.

On November 29, 1984, as a result of a passenger train accident in Wilmington, Illinois, in 1983, 4/ the Safety Board issued Safety Recommendation R-84-46 recommending that the FRA:

> Expedite the studies on the interior design of passenger cars described in the January 1984 report to Congress, and publish recommended guidelines for securing seats and for luggage retention devices.

The FRA has not yet responded to Safety Recommendation R-84-46, and it is therefore reiterated as a result of this accident.

Also, as a result of the Wilmington accident, the Safety Board issued Safety Recommendation R-84-40 on November 29, 1984, recommending that Amtrak:

> Correct the identified design deficiencies in the interior features of existing and new passenger cars, which can cause injuries in accidents, including the baggage retention capabilities of overhead luggage racks, inadequately secured seats, and inadequately secured equipment in food service cars.

3/ Railroad Accident Report--"Richmond, Fredericksburg and Potomac Railroad Company Train No. 10/76 Derailment with Three Fatalities and Numerous Personal Injuries, Franconia, Virginia, January 27, 1970" (NTSB-RAR-71-1).

4/ Railroad Accident Report--"Collision of Amtrak Passenger Train No. 301 on Illinois Central Gulf Railroad with Marquette Motor Service Terminals, Inc., Delivery Truck, Wilmington, Illinois, July 28, 1983" (NTSB/RHR-84/02).

Although Amtrak has not replied to the recommendation, Amtrak has made attempts in the past to incorporate better securement of both seats and baggage. The newer passenger cars will withstand a longitudinal force in excess of that which will propel a person out of the seat. Safety Board investigators observe that in most crash instances, the seats sometimes partially rotate due to broken seat positioning latches, but the seat frames and seats normally remain in place in the retaining tracks. Further refinements may be needed, but this accident demonstrated that seat back and seat frame failures have been markedly reduced.

Amtrak has made design changes in the overhead luggage racks by adding rubber bumpers along the length of the luggage racks to reduce end-to-end luggage movement. In addition, the portion of the luggage rack which faces the aisle has an added raised edge to provide better luggage retention. However, these design changes did not eliminate luggage being propelled out of the overhead racks in this accident or in an accident at Woodlawn, Texas, on November 12, 1983. 5/ Further design changes are needed to reduce injuries from unrestrained luggage in accident situations.

Amtrak Locomotive Maintenance Practices

In general, Amtrak maintenance and inspection standards were found to equal or exceed normally acceptable industry standards for railroad locomotives. An exception was noted at the New Haven shop, where the condition of the support bearing finish on locomotive axles in the traction motor support bearing area did not comply with existing industry standards or the manufacturer's maintenance instructions. The fact that the most recent revision to the maintenance instruction on traction motor support bearing finish was not in the New Haven shop maintenance instruction library is indicative of a possible communications breakdown between the shop and Amtrak Mechanical Department headquarters as well as between the shop and EMD. About 3 years had passed since the revision to the instruction was issued, and the shop at New Haven was not aware of the change. Additionally, a change in finish specifications from a 15-microinch finish to a 7-microinch finish is a significant change which requires a special tool (a profilometer) to detect. This special tool was not available to the assemblers at New Haven, although the tool was available and in use at the adjacent New Haven wheel and axle shop.

Examination of the broken axle from Amtrak locomotive unit No. 378 revealed that the damage to the surface finish of the axle in the failure area was too severe to measure and determine the actual condition of the original surface. The surface finish of the traction motor support bearing journal on the other (commutator) end of the axle was measured at 30 microinches. This surface finish measurement is over four times that which is recommended by the manufacturer and adopted as standard by Amtrak. Even allowing for some deterioration of finish due to derailment, it is unlikely that the surface was at the specified level of 7 microinches when the axle was applied to the assembly at the New Haven shop. There were marks on the bearing surface which suggest that a hand-held polishing tool was used on the axle which not only roughened the surface but also left "peaks and valleys" which can result in excessive bearing wear and interrupted lubrication. Therefore, the Safety Board believes that the surface finish of the failed end (pinion end) of the axle was in reasonably similar condition to the commutator end of the same axle when it was applied to the assembly. Since the bearing load on the pinion end is approximately three times as great as the load on the commutator end, the bearing on the

5/ Railroad Accident Report--"Derailment of Amtrak Train No. 21 (The Eagle) on the Missouri Pacific Railroad, Woodlawn, Texas, November 12, 1983" (NTSB/RAR-85/01).

pinion end would be expected to fail first. The failure mode is characterized by (1) excessive bearing wear, (2) overheating of the axle and bearing, (3) degradation of the wick-type lubrication system, and (4) ultimate failure of the axle in the support bearing area when the axle becomes plastic due to overheating.

CONCLUSIONS

Findings

1. Train No. 81 was being operated in accordance with existing Amtrak and Seaboard System Railroad rules and operating practices.

2. The wayside hot box detection system did not detect the overheated traction motor support bearing, because it cannot detect overheated bearings located between the rails.

3. The traincrew did not detect the presence of the overheated traction motor support bearing during their routine en route inspections.

4. There was no onboard detection system to identify the presence of an overheated traction motor support bearing.

5. The first signs of axle failure on train No. 81 were the marked grade crossing planks at Kittrell and the presence of sparks emitting from the locomotive when it passed Kittrell.

6. The No. 1 wheel of Amtrak locomotive unit No. 378 derailed near MP S-123 and struck a switch approximately 2,000 feet south of MP S-123, causing the following 18 cars to derail.

7. The Amtrak shop in New Haven that assembled the traction motors for Amtrak locomotive unit No. 378 did not have the latest maintenance instructions for locomotive wheels, axles, gears, and pinions.

8. The traction motor support bearing journals on the No. 1 axle from Amtrak locomotive unit No. 378 did not meet the applicable maintenance standards.

9. The metallurgical examination of the No. 1 axle from Amtrak locomotive unit No. 378 revealed that the axle failure was typical of those which are caused by overheated bearings.

10. The rescue efforts of the local emergency response units were timely, efficient, and effective.

11. The passive luggage restraint system used in Amtrak passenger cars was ineffective in this accident.

12. The majority of the injuries were caused by passengers striking the interior appurtenances of the cars or by luggage striking the passengers.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the overheated No. 1 axle on locomotive unit No. 378. The overheating was due to bearing metal pickup and excessive bearing wear of the pinion end traction motor support bearing because of a substandard finish on the axle journal surface. Contributing to the accident was the lack of an effective system to detect overheated traction motor support bearings before failure. Contributing to the number of injuries was unsecured luggage falling from overhead luggage racks.

RECOMMENDATIONS

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

--to the National Railroad Passenger Corporation (Amtrak):

Develop and install a system on all passenger train locomotive units that will detect and inform crewmembers of the presence of overheating traction motor support bearings. (Class II, Priority Action) (R-85-13)

Review current quality control procedures on locomotive wheel shop practices and the method of updating locomotive maintenance information to ensure that quality control procedures are adequate and that current information is available to the maintenance forces at all Amtrak locomotive maintenance facilities. (Class II, Priority Action) (R-85-14)

—to the Association of American Railroads:

Inform its members of the facts, conditions, and circumstances of the accident at Kittrell, North Carolina, on March 5, 1984, and encourage them to examine their locomotive maintenance information on traction motor support bearings to ensure that it is current and is being followed. (Class II, Priority Action) (R-85-15)

In cooperation with the General Electric Company and the Electro-Motive Division of the General Motors Corporation, examine the design of, and maintenance procedures for, traction motor support bearings, determine if the existing bearing arrangement and maintenance procedures are adequate for the present operating environment, and make any necessary adjustments in design and maintenance. (Class III, Longer-Term Action) (R-85-16)

--to the Electro-Motive Division of the General Motors Corporation:

In cooperation with the Association of American Railroads and the General Electric Company, examine the design of, and the maintenance procedures for, traction motor support bearings, determine if the existing bearing arrangement and maintenance procedures are adequate for the present environment, and make any necessary adjustments in design and maintenance. (Class III, Longer-Term Action) (R-85-17)

--to the General Electric Company:

> In cooperation with the Association of American Railroads and the Electro-Motive Division of the General Motors Corporation, examine the design of, and the maintenance procedures for, traction motor support bearings, determine if the existing bearing arrangement and maintenance procedures are adequate for the present environment, and make any necessary adjustments in design and maintenance. (Class III, Longer-Term Action) (R-85-18)

Also as a result of its investigation of this accident, the National Transportation Safety Board reiterated the following recommendations:

--to the National Railroad Passenger Corporation (Amtrak):

> Correct the identified design deficiencies in the interior features of existing and new passenger cars, which can cause injuries in accidents, including the baggage retention capabilities of overhead luggage racks, inadequately secured seats, and inadequately secured equipment in food service cars. (R-84-40) (issued November 29, 1984)

--to the Federal Railroad Administration:

> Expedite the studies on the interior design of passenger cars, described in the January 1984 report to Congress, and publish recommended guidelines for securing seats and luggage retention devices. (R-84-46) (issued November 29, 1984)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ G. H. PATRICK BURSLEY
Member

March 5, 1985

APPENDIXES

APPENDIX A

INVESTIGATION

Investigation

The National Transportation Safety Board was notified of the accident early in the evening of March 5, 1984. Investigators were dispatched from the Safety Board's Washington headquarters and the Atlanta and Fort Worth field offices. Safety Board investigators were assisted by representatives of the Federal Railroad Administration, the Seaboard System Railroad, the National Railroad Passenger Corporation (Amtrak), the Vance County (N.C.) Sheriff's Department, the Kittrell (N.C.) Volunteer Fire Department, and the Electro-Motive Division of the General Motors Corporation.

Deposition/Hearings

No formal depositions were taken nor was a hearing held in conjunction with this investigation.

APPENDIX B

TRAINCREW INFORMATION

The locomotive engineer, 65, entered service as a fireman with a predecessor of the Seaboard System Railroad on January 3, 1942. He was qualified as an engineer on March 16, 1944.

The locomotive fireman, 37, entered service as a switchman with a predecessor of the Seaboard System Railroad on January 16, 1969. He was transferred to fireman on April 27, 1977, and qualified as an engineer on August 19, 1978.

The train conductor, 44, entered service as a trainman with a predecessor of the Seaboard System Railroad on July 19, 1962. He qualified as freight conductor on September 1, 1966, and as passenger conductor on February 3, 1969.

The flagman, 40, entered service as a trainman with a predecessor of the Seaboard System Railroad on October 17, 1965. He qualified as a freight conductor on May 14, 1968.

The baggagemaster, 56, entered service as a trainman with a predecessor of the Seaboard System Railroad on July 13, 1946. He qualified as a freight conductor on January 31, 1958.

APPENDIX C

ASSOCIATION OF AMERICAN RAILROADS LETTER SUMMARIZING METALLURGICAL REPORT RESULTS

ASSOCIATION
OF AMERICAN
RAILROADS

H. H. Stone
Director-Metallurgy

August 31, 1984

Mr. J. S. Crawford, Jr.
Chief Mechanical Officer
National Railroad Passenger Corporation
400 North Capitol Street, N.W.
Washington, D.C. 20001

Dear Mr. Crawford:

The purpose of this letter is to summarize the results of our findings in the investigation of the failed axle which had been submitted to our laboratory for failure analysis.

The cause of failure of the axle has been attributed to gross overheating of the suspension bearing journal at the pinion end of the traction motor. This overheating resulted in extensive bearing metal penetration, as evidenced by deposits of lead and copper discovered in subsurface cracks. During the overheating of the axle, an extensive secondary crack network developed, indicative of a severe breakdown in mechanical properties at high temperature. A combination of the embrittling action of the bearing metal contamination and the loss of strength, therefore, is judged to be the cause of axle failure.

The remaining item in the investigation was to determine the cause of this overheating.

A lack of lubrication at the bearing/axle interface would cause such overheating, and the most likely source of this condition is felt to be attributable to the condition of the axle suspension bearing journals. The journal at the commutator end of the axle was examined and was found to have circular polishing scratches on its surface, suggestive of an operation employing a hand-held polishing tool. Upon more precise examination, it was determined that these markings corresponded to areas of exaggerated out-of-roundness traces on the journal surface. Further, these "peaks and valleys" were examined on the electron microscope, and were associated with bearing metal pick-up and excessive wear. Also, the surface finish of the journal at the commutator end was found to be about 38 micro-inches on the average, while 7 micro-inches are considered too extreme for service.

Because the condition of the pinion end journal was too severely damaged to allow for such a precise examination, it was assumed that the condition at both ends of the axle would be reasonably similar. Therefore, given the results of the journal surface examination at the commutator end, and remembering that the loading at the pinion end of the axle may be roughly three times as great, the pinion end was reasoned to have undergone a more severe attack than that at the commutator end. This attack is felt to have been characterized by excessive bearing wear, resulting in overheating and degradation of the lubrication wick, and

Research and Test Department-Technical Center
3140 South Federal Street, Chicago, Illinois 60616 (312) 567-3680

APPENDIX C

ultimately, in overheating and failure of the full axle/bearing region.

The mechanical properties of both ends of the axle were determined, and were found to be both compatible with one another, and within established axle criteria. No suggestion of any manufacturing defect was found in this investigation.

This letter is meant to precede publication of the formal AAR report on this failure analysis, which will of course be more detailed. Should the need for clarification on any points arise, interested parties may contact Mr. David Utrata of the AAR Technical Center at (312)567-3633.

Sincerely,

D. H. Stone

DHS/DU/bjv

cc: W. J. Harris, Jr.
G. H. Way
J. G. Britton
K. L. Hawthorne
R. K. Steele
J. W. Hutchison
R. Burke