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RAILROAD ACCIDENT REPORT

PENN CENTRAL COMPANY
TRAIN SECOND 115 (SILVER STAR)
DERAILMENT AT
GLENN DALE, MARYLAND
JUNE 28, 1969

NATIONAL TRANSPORTATION SAFETY BOARD
Bureau of Surface Transportation Safety
Washington, D. C. 20591

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FOREWORD

The field investigation was conducted by the National Transportation Safety Board in cooperation with the Federal Railroad Administration (FRA). This investigation included a public hearing which was held by the Safety Board in Washington, D. C., on August 18, 19, and 20, 1969. This report of facts and circumstances and determination of cause by the Safety Board is based on the facts developed in the field investigation and public hearing.

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Train Second 115 (Silver Star)
Derailment at
Glenn Dale, Maryland
June 28, 1969

I. SYNOPSIS

The "Silver Star," operating as Penn Central Train 2nd 115, derailed on Penn Central tracks at Glenn Dale, Maryland, about 1:23 p.m., June 28, 1969. Among the 541 passengers in the 18 cars, 144 persons were transported to area hospitals, 12 of whom were admitted. Total estimated damages, excluding personal injuries were in excess of $300,000.

During the derailment, the train parted between the 12th and 13th cars when the coupler pulled out of the rear of the 12th car. The eighth through the 12th cars derailed but remained coupled and stopped upright on the track structure. The 13th through the 16th cars veered to the right, down off the track structure, and completely or partially overturned on their right sides. The 17th and 18th cars remained upright and the 18th car stopped on the track structure about 540 feet south of the point of derailment.

The Safety Board determines that the derailment was caused by lateral movement of the track under the train. The lateral movement was caused by buckling of the track.

The track buckled because of high compressive forces caused by heat expansion and the tendency of rail to creep in the direction of the predominant flow of traffic and descending grade. The absence of a full ballast section, irregular compaction of the ballast, and reduced density of ballast below crossties resulting from boring operations are possible contributing factors which could not be ruled out. A slight misalignment of the track produced lateral movement of the cars which may have initiated the buckling of the track, which was already under high compressive force.

A number of injuries to passengers were caused by their being thrown from the seats and striking interior parts of the cars and by luggage being thrown about inside cars.

II. FACTS

A. Location and Method of Operation

The derailment occurred at Glenn Dale Road crossing about 13 miles north of Washington, D. C. Glenn Dale is located on the Chesapeake Division of the Penn Central Company's Eastern Region between Washington and Baltimore.

The railroad through Glenn Dale is a three-track line running approximately north and south. In this report, timetable directions of North and South will be used. The tracks are numbered from east to west as main tracks 1, 2, and 3. Track No. 1 is equipped with signals for train movement in a northward direction only and is used primarily as a freight track. Tracks 2 and 3 are equipped with signals for train movements in either direction on signal indication. Generally, southbound trains operate on No. 3 track and northbound trains on No. 2 track. Passenger trains normally operate on tracks 2 and 3 because of a 50 mile-per-hour speed restriction on No. 1 track. All trains normally operate by indication of an automatic-block signal system in the accident area.

On the day of the accident, the train, Seaboard Coast Line's "Silver Star," was operating southbound on No. 3 track as Penn Central train 2nd 115.

The maximum authorized speed for normal passenger trains on tracks 2 and 3 was 100 miles per hour; however, some passenger trains are restricted to 80 miles per hour because of equipment considerations. Train 2nd 115 on June 28 was authorized a maximum speed of 100 miles per hour. Metroliners are authorized a maximum speed of 120 miles per hour on tracks 2 and 3. Freight trains are restricted to a maximum speed of 50 miles per hour on all tracks. All trains are restricted to 50 miles per hour on No. 1 track.

Glenn Dale Road crosses all three tracks at grade about 630 feet south of milepost 123. The crossing was constructed of creosoted timber to a point 2 feet outside the rails of each track, and the intertrack space was paved with blacktop to the top of the rail over compacted crushed stone track ballast. The crossing is equipped with automatic gates and flashing lights which are activated by an approaching train from either direction.

Duval Street runs from Glenn Dale Road southward for about 750 feet adjacent to the west side of the tracks before diverging to the west. An unimproved road runs adjacent to the east side of the tracks from Glenn Dale road southward. (See Appendix 1.)

B. Description of the Accident

1. Train and Crew

Penn Central train 2nd 115 (Seaboard Coast Line's "Silver Star") left New York at 9:34 a.m., June 28, 1969. The train consisted of one GG-1 electric locomotive, one dormitory car, one tavern car, two diners, four sleepers, and 10 coaches. There were 494 passengers assigned to coaches and 47 sleepers at the time of the derailment.

The locomotive was not equipped with a device for recording speed but did have a speedometer. It was equipped with a radio by which the engineer could communicate with land stations and other trains on the same frequency within range.

All of the cars in the train were the so-called stainless steel cars. The coaches ranged in weight from 108,000 to 125,000 pounds and the sleepers averaged about 141,000 pounds each. They were designed to comply with the requirements of the Railway Mail Service specifications. All cars were equipped with Type H, tightlock couplers and trucks with locked center pins. The seats in the coaches were manufactured by various companies but were of the same general type. Each seat had a reclining back, accommodating two persons, and could be reversed by manually rotating it on a center pin. There was no positive latch to prevent the seats from rotating from impact or rollover forces. The windows had double-glazed sashes with 1/4-inch plate glass on the outside and 1/4-inch shatterproof glass on the inside. The coaches were equipped with overhead luggage racks on each side with no restraining devices to hold luggage in place except a 1/4-inch lip on the edge. Each car was equipped with emergency tools sealed in a glass-enclosed cabinet. The only emergency exits are through the regular doors at each end of the cars. These doors either slide laterally into the bulkhead or swing inward. 1/

The locomotive and cars had received the required inspections and tests before leaving New York. No defects were reported. During the trip from New York prior to the initial derailment, no persons on the train or observers from the outside noted any unusual condition of the train that could have contributed to the accident.

The engineer operated the locomotive from the customary seat on the right-hand side during the entire trip from New York to the point of derailment. The fireman performed his duties from his normal location on the left-hand side of the locomotive. The train crew, a conductor and three trainmen, moved about throughout the train in the normal performance of their duties. The rest and hours of service of the train and engine crews were within the requirements of the Hours of Service Law.

In addition to the Penn Central train and engine crews, Seaboard Coast Line employees on duty on the train included a registered nurse, dining car employees, and coach attendants.

1/ An inward swinging door, jammed by the press of people trying to escape burning oil from a tank truck which had been struck by a railway diesel car in Everett, Massachusetts, in December 1966, contributed to the deaths of 13 persons. See NTSB Accident Report of Boston and Maine Corporation, Single Diesel-Powered Passenger Car 563 Collision with Oxbow Transport Company Tank Truck at Second Street Railroad-Highway Grade Crossing, Everett, Massachusetts, December 28, 1966.

2. Weather

The temperature at the time of derailment was between 98° and 100° F. The sun was shining brightly only 16°, lower than the hottest elevation of the day, and only a slight breeze was blowing.

3. Track

In the derailment area, No. 3 track was constructed of 1,440-foot lengths of 140-pound continuous welded rail which was installed in December 1966. The rails were fastened to each 7- by 9-inch creosoted crosstie (22 per 39-foot rail) by two rail-holding and one anchor spike per tie plate. The tie plates were heavy duty, double shoulder, 7 3/4 by 14 3/4 inches. The rails were anchored against longitudinal expansion in both directions on every tie for 234 feet from the joints of the welded strings and on alternate ties in the area between the points of full anchorage. The ballast level varied from 1 inch below the tops of the crossties in the center of the track to as low as 3 inches below the tops of the ties at their ends.

The alignment in the derailment area was straight. North of Glenn Dale grade crossing is a 0.75-percent descending grade, 3,000 feet in length, which changes to a 0.28-percent ascending grade, 608 feet north of the point of derailment.

The rail in No. 3 track was rolled at the Carnegie mills of the United States Steel Company in 1966. In October of 1966, the Linde Division of the Union Carbide Corporation, using the oxyacetylene pressure butt weld method, welded the 39-foot rails into 1,440-foot strings.

The temperature of the welded rail was low when the rail was installed at Glenn Dale in December 1966. The rail south of the crossing was heated to 70° F. and anchored. That part north of the crossing was adjusted to 70° F. in May 1967 and re-anchored, resulting in a theoretical destressed rail temperature of 70° F.

New crossties were installed where required in No. 3 track in 1965. The track was last surfaced with a Plasser mechanical tamper in May 1967. The surface of the welded rail was ground with grinding cars in 1967. The track was last tested by the Sperry rail flaw detector car, before the accident, on October 4, 1968. No defects in the continuous welded rail were reported.

The track was last inspected by a foreman-track inspector on June 26, 1969, two days before the derailment. The same inspector inspected the track on foot on June 25 and 26 and took no exception to the track condition. The track supervisor personally saw the track on June 16 and rode over it on a train on June 25, and he took no exceptions to the condition or riding qualities of No. 3 track in the accident area.

The grade crossing at Glenn Dale Road was renewed during March and April 1969. The old crossing was removed, and the ballast was removed in the crossing area to the bottom of the ties. New crossties were installed north and south of the crossing where the crossing was widened from 24 feet to 32 feet. New ballast was added and the track was raised about 1 1/2 inches and tamped with a mechanical tamper. The 1 1/2 inch raise through the crossing was run out for a distance of about 200 feet in each direction. Rail anchors were not applied within the limits of the grade crossing because it was not considered necessary. The construction of the grade crossing effectively resisted movement of the track in the crossing. About 40 new crossties were installed north of the crossing and tamped.

On April 16, 1969, the track north of the crossing was retamped because of settlement. The tamping was done by hand with tamping picks, but no new ballast was added. Photographs (see figure 1, page 6) and observation indicated insufficient ballast in the buckled area to meet the requirements of the Penn Central's recommended standards.

Between June 25 and 27, a contractor bored a 6-inch hole under the tracks to install a conduit in connection with the installation of additional crossing protection devices at Glenn Dale. This bore was made about 30 feet north of the crossing and 5 feet below the rail. This was in the area where the track buckled. The contractor made three unsuccessful bores before he finally bored completely under all three tracks. At least two of the unsuccessful bores were under No. 3 track and one of them broke out of the surface between No. 1 and No. 2 tracks. The bore which broke out in the track area was partially filled, but the filling did not extend under No.3 track. Neither the unsuccessful bores nor the voids around the 2-inch conduit in the successful bore were filled under No. 3 track.

The Penn Central Company specified that the work of the contractor should be done 10 feet outside the nearest track and 5 feet below the track. A Penn Central inspector was in attendance part of the time to assure that the bore did not strike any signal or communication lines. Although the inspector was on hand when the unsuccessful bore broke out of the surface between tracks No. 1 and No. 2, some of the boring was made under tracks used by the Metroliner and other passenger trains at high speeds without an inspector in attendance. The track supervisor, who was responsible for maintaining safe track in that area, was not aware that anybody was working adjacent to the track there at the time.

Members of the engineering staff of the Office of High Speed Ground Transportation (OHSGT) observed a slight misalignment in No. 3 track, 41 feet north of Glenn Dale Crossing. They noted this misalignment during a routine field check on June 19, 1969, which was conducted to correlate field measurements of track geometry with the recordings obtained by OHSGT test cars. This particular misalignment was not recorded by the test car but was noted by eye as the group was crossing the tracks at Glenn Dale Crossing. Based on the field measurements, the misalignment was within the tolerances set in the OHSGT requirements for the Northeast Corridor Transportation Project.

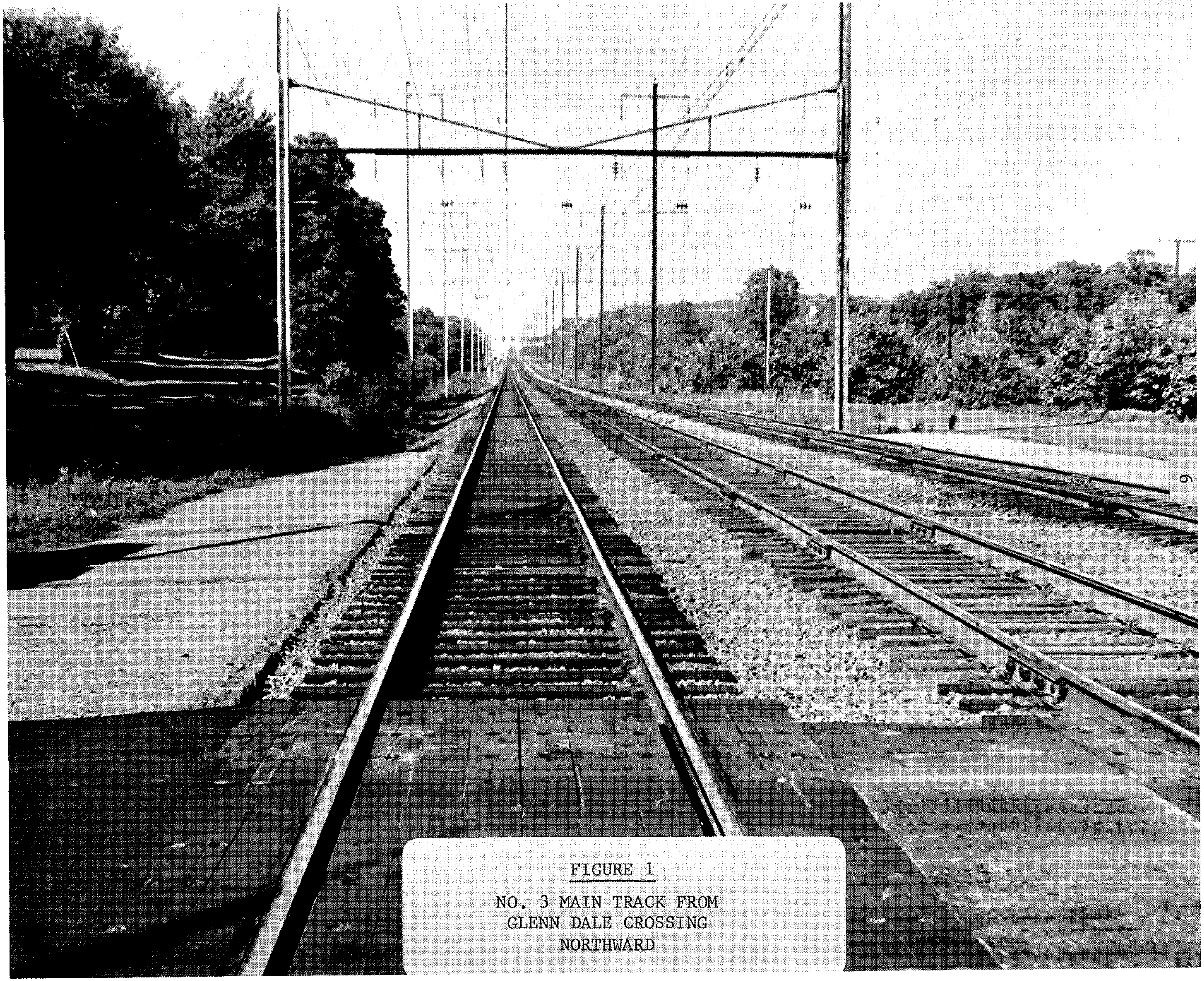

FIGURE 1

NO. 3 MAIN TRACK FROM
GLENN DALE CROSSING
NORTHWARD

The photograph on page 6 was taken by a Penn Central Claim Agent on May 26, 1969, in connection with another matter. It accurately depicts the crossing and the track north of the crossing as it was on June 28 before the accident. A slight misalignment can be seen in the east rail about 40 feet north of the crossing.

The contract between OHSGT and the Pennsylvania Railroad (now Penn Central Company) for the Northeast Corridor Transportation Project related track standards to Pennsylvania Railroad's "Specifications for Construction and Maintenance of Track, C. E. 78." The manual C. E. 78 has now been superseded by the Penn Central Company's "Manual of Standard Practice for Construction and Maintenance of Track, M.W.1." Although the contract provides that the railroad shall take proper safety and health precautions to protect the public, there is no basis in written documentation or standards by which OHSGT can insure that this safety portion of the contract, as it relates to track condition, will be fulfilled once the demonstration begins.

The engine crew and conductor on train 2nd 115 reported that as they passed over the point of derailment, they felt nothing in the ride quality to indicate that the derailment was imminent.

4. Traffic

There were 1,011 southbound trains which passed Glenn Dale during the period May 29 to June 28, 1969. Of those trains, 890 (88 percent) used No. 3 main track. Only one train, a nine-car passenger train on May 29, moved northward on No. 3 track during the preceding 30 days.

5. Derailment

Train 2nd 115 was running between 83 and 85 miles per hour as the locomotive crossed the Glenn Dale Road Crossing. Neither the engineer nor the fireman saw anything or felt anything unusual as he passed over the crossing. Shortly after the locomotive passed the crossing, there was an emergency application of the train brakes and, as far as the engineer and fireman could determine, the train came to a smooth stop. As the train was stopping, both engineer and fireman looked back and saw the rear part of the train engulfed in smoke and dust. The engineer immediately transmitted a radio message to block all tracks. This message was received and acted on by the operator at Bowie Interlocking Tower. The fireman on the head end and the flagman on the rear end provided flag protection against other trains as required by the Penn Central rules.

The conductor was riding in the third car from the locomotive, and his first indication of trouble was the emergency application of the brakes. After he saw the smoke and dust around the rear part of the train, he went immediately to the locomotive to assure himself that the fireman was protecting against northbound trains. Then he went toward the rear of the train to evaluate the situation.

One trainman in a bedroom near the forward end of the sleeper Raritan River first knew of the derailment when he felt the car lurch. He was thrown back into a chair and braced himself against a bulkhead while the car overturned on its right side. Recovering quickly, he assisted several passengers out through the forward door. There were no serious injuries to passengers in that car.

The flagman in the fifth car from the rear thought he noticed an emergency brake application and derailment almost simultaneously. He was thrown about considerably and slightly injured. In spite of his injuries, the flagman assisted injured passengers and attended to his flagging duties at the rear of the train.

The time of the derailment was established by evidence to be 1:23 p.m.

An inspection made after the derailment indicated that No. 3 track had moved laterally eastward up to 7 inches throughout a distance of 45 feet north of the crossing. There were wheel marks on the gage of the west rail at the fifth crosstie north of the crossing and on the east rail at the fourth crosstie. Wheel marks through the crossing and on the gage of the east rail indicated that the initial derailment occurred toward the east just at the north edge of the crossing. Some of the derailed wheels dropped inside of the east rail and canted it eastward as they passed through the flangeway of the crossing. The blacktop paving between the timber crossings of No. 3 and No. 2 tracks was bulged upward about a foot by the lateral movement of the track in the crossing.

C. Results of the Derailment

1. Trajectory of and Damage to Cars

The rear trucks of the eighth car and both trucks of the ninth through the 18th cars derailed. There was a separation between the 12th and 13th cars. (See Appendix 2, Page 38)

The eighth through the 12th cars remained coupled to the head part of the train and bounced over the crosstie and ballast until they stopped with the 12th car, 2,968 feet south of the Glenn Dale Crossing. All of these cars remained upright, upon and in line with the track. There was evidence of one or more cars having left the track structure about 1,200 feet south of the point of derailment. They remained upright and came back onto the track structure, generally in line before stopping. The part that the welded rail and design of the track structure played in restraining the cars from possible disastrous collision with the catenary poles will be discussed later.

In the 12th car, a diner, a number of chairs were overturned and dishes were thrown from the tables during the rough ride after the derailment. The tables were not upset because they were attached to the floor. Firemen broke out some windowpanes for ventilation after the accident but none of the windows broke during the derailment.

The coupler pulled out of the rear of the 12th car, SCL Diner 5900, during the derailment. The H-type, tightlock coupler and yoke remained coupled to the south coupler of the 13th car. This coupler is shown in the photograph in Figure 2, page 10.

The draft arrangement was designed to withstand a force of 428,000 pounds in tension, but the degree of torque to be resisted was not specified. The damage to the center sill, where the draft stops failed, indicates the draft stop on the left side was subjected to forces for which it was not designed.

When the coupler pulled out of the rear of the 12th car, the 13th car veered to the right (west), and downward, digging into the subgrade and overturning to the right. The 14th through the 18th cars remained coupled to the 13th car and followed the same route established by the 13th car. The separation of the cars initiated the emergency brake application. The south end of the 13th car stopped 1,047 feet beyond the Glenn Dale Crossing, and the rear of the 18th car stopped 537 feet beyond the crossing. The photograph in Figure 3 on page 11 shows the overturned cars with the 13th car in the foreground. The corner of that car had dug into the ground, pushing earth in bulldozer fashion and producing a substantial decelerative force described by witnesses.

During the derailment, witnesses on the train and near the tracks reported seeing orange flames. Inspection of the cars after the derailment disclosed that the flames were only momentary and caused no damage to the cars. The flames apparently resulted from ignition of gas being emitted from the breaking of the car batteries.

The six rear cars received no significant structural damage from the derailment. Appurtenances such as batteries, air reservoirs, and generators were heavily damaged and, in some cases, torn off. The right sides of the 13th, 14th, and 15th cars were damaged and a few window glasses were broken when these cars overturned.

Many of the seats in the coaches pivoted on their center bearings, throwing the passengers from the seats. The luggage on the racks was thrown to the right sides of the coaches which overturned. Unanchored railroad car furniture was found after the accident on the side walls of car 14. This included three chairs, two ash trays, and two heavy floor-standing ash trays. In addition, a large and heavy planter had broken loose from its attachments on the wall and had fallen against the side wall of the car.

All of the cars in the derailment were equipped with trucks with locked center pins to prevent their coming off during a derailment. The cars and trucks were also designed so that the rotation of the trucks on their center pins was limited by the center sills. These design features kept the trucks attached and in line with the longitudinal axes of the cars.

FIGURE 2

TIGHTLOCK COUPLER FROM
SCL DINER 5900 STILL
COUPLED TO COUPLER OF 13TH CAR

FIGURE 3

OVERTURNED CARS WITH
13TH CAR IN FOREGROUND

The cars which overturned passed very close to the upright members of the catenary system. These upright members are 14-inch standard, steel H-beam sections weighing 87 pounds per foot, buried in concrete and guyed to the outside with a woven steel cable. The lateral support members of the catenary system are stretched between these upright members which are erected on opposite sides of track.

2. Damage to Track

No. 3 track south of the crossing was badly damaged by the derailment. For a distance of about 1,565 feet, the rail was completely torn out, the crossties torn out or badly damaged, and the ballast seriously plowed up by the derailed wheels. Beyond this, for an additional 1,780 feet, the rail was damaged and overturned. There was less damage to crossties and ballast in this area.

The east rail broke in a weld about 166 feet south of the point of derailment. The fracture faces showed that about two-thirds of the area of the head fractured in an atypical plane break, with no evidence of progressive fractures, while the balance of the fractured head, web, and base fractured in a cleavage mode. The two-thirds area was flat and smooth, and grinding marks were still present. The area had clearly not fused to any significant degree during the welding cycle. The flat surface was clean and showed no rust. A magnetic particle test of the incomplete weld had not indicated the presence of a surface crack.

It can be seen from Figure 4 on page 13 that the welded rail on the west side played a significant part in keeping the cars in line with the track structure. This illustration clearly indicates that some derailed cars on the front part of the train had moved down off the track structure toward catenary supports during the slowing of the cars, but were restrained and led back up to the structure and thereafter retained on the track structure. In the illustration, the movement of the cars was toward the viewer.

3. Casualties

The only fatality resulting from the accident was the death of a passenger, riding in one of the overturned cars, who suffered a heart attack after escaping the wrecked train.

One hundred and forty-four passengers were transported to five area hospitals. Twelve persons were admitted and the remainder were treated and released. Many others received attention from emergency squad personnel at the scene of the derailment. Several volunteer firemen were overcome by the heat during rescue operations.

FIGURE 4

DISTURBED WELDED RAIL
WHICH RESTRAINED CARS
FROM GOING OFF ROADBED

The Glenn Dale Fire Association responded immediately and had men and equipment on the scene within 3 minutes after the derailment. A total of 10 fire engines and 19 ambulances performed service in putting out three brush fires and attending to the needs of the injured. The source of the brush fires was not determined but was believed to have been sparks from the derailment impact. No fire sources of more than momentary duration could be found. The flash of fire reported was beneath a car which stopped more than 300 feet short of the scene of the brush fires.

The injuries included fractures, but most of the injuries were lacerations, contusions, and general body bruises. With the exception of the burns received by dining car employees, the injuries resulted from persons being thrown from their seats or being struck by flying baggage or furniture.

4. Escape and Treatment of the Injured

Escape of the injured proved to be a problem in the first three overturned cars. The right-hand windows of these cars were on the ground or a few inches above the ground, and the left-side windows were at least 4 feet above the heads of passengers, most of whom were standing on the lower side windows of the cars after the overturning. Passengers were evacuated from the front of the 13th car. A large number of passengers were also evacuated through the right door opening of the 14th car, after dirt was removed to make a passageway. It was possible to crawl through the opening thus made. Several passengers escaped through the right-hand windows of the 14th car after the glass was broken. They then crawled lengthwise under the side of the car and outward to escape from beneath the car. It was necessary for those passengers in the 14th car who escaped through the crawl tunnel to slide sideways on the side walls in the car a distance of about 12 feet to reach the vestibule.

Some passengers escaped through the upper windows after firemen placed ladders on the sides of the cars and broke out the windows.

The air conditioning failed when the power went off and, within a short time, the estimated temperature in the interior of the cars reached about 120° to 130° F. This was a very difficult problem for those who were escaping, as well as for the rescuers. Fans were placed by firemen to ventilate the interior; however, even the ventilating air was at 98° to 100° F.

The lower windows in the 14th car were broken out by a passenger at some risk to himself. He did not employ the emergency escape equipment (which was located in the aisle less than 10 feet from the window that was broken out) because he did not realize it was there. This escape equipment was located in a compartment behind a glass door on the wall of the aisle of the car. The tools were well camouflaged because the glass frame, the escape tools, the interior of the tool compartment, and the walls of the car were all painted the same color--a light green. There was no sign to indicate the purpose of the glass-doored compartment.

The person who died of a heart attack was one of those who escaped from the 14th car either through the side window or by crawling through the dug-out opening. Considerable exertion was necessary to negotiate the passageway in this area due to its position. With the car lying almost on its side, the height of the corridor was too low to allow standing. It is not known how this person escaped.

A registered nurse, an employee of the Seaboard Coast Line Railroad, was in the forward part of the train when the derailment occurred. The New York-Florida trains of Seaboard Coast Line Railroad are the only regularly scheduled trains in the United States which regularly carry medical attendants. When the train stopped, she hurried to the site where the damage appeared to be greatest, which was approximately 3/8 of a mile to the rear. She was the first crewmember from the front of the train to arrive at the major damage area of the derailment. She treated approximately 50 persons for injuries and prepared some for transit to the hospital. She did not attend the person who died of a heart attack. Medical supplies carried on the train were employed in treating the injuries, but the quantity was insufficient.

5. Estimated Damages

The estimated damage to physical property of the Penn Central Company was as follows:

Equipment	$ 204,900
Track and roadbed	70,000
Other property	8,000
Clearing wreck	21,600
	$ 304,500

The cost of the personal injuries, delay to passengers, and interruption to and loss of freight traffic is not considered in the above total.

III. ANALYSIS

A. Track as a Causal Factor

The most probable sequence of events in the track buckling and initial derailment is as follows:

> The initial misalignment of the track developed gradually under the train at a point about 30 to 40 feet north of the crossing. The buckling was probably initiated by lateral movements of the cars passing over the slight misalignment. Once the

> buckling started, it was aggravated by the movement forces of the trucks until the misalignment became great enough to cause derailment. The road crossing resisted lateral buckling until after derailment, thus causing a sharper curve in the track where it entered the north edge of the crossing. It was in this sharper curve that the initial derailment occurred. After the initial derailment occurred, the track was knocked out of alignment further and, as indicated by loose and thrown ballast on the west side, the track whipped back westward one or more times.

A number of causal factors were involved in the buckling of the track which resulted in the initial derailment. Inspection of the cars revealed no evidence that they contributed to the derailment.

After tamping and lining, a track is held in line against lateral buckling by the friction between the crossties and the ballast, aided to a somewhat lesser degree by the weight of ballast at the end of crossties. The Penn Central's requirements for ballast are listed in its Manual of Standard Practice for Construction and Maintenance of Track (M.W.1). This manual, M.W.1, effective October 1, 1968, superseded the Pennsylvania Railroad's former Manual, C.E. 78. The requirements of Manual M.W.1 were in effect in April 1969 when the track through the crossing was raised and the track reballasted. The preface of Manual M.W.1 states in part:

> "It is not the intent of this manual to establish arbitrary procedures, but to serve as a guide to economical standards of track construction and maintenance and must be interpreted in the light of experience and the requirements of the service."

Manual C. E. 78 recommended that welded rail track have ballast one-half of an inch below the tops of the crossties between rails and level with the tops of the crossties outside the rails for a distance of 6 inches beyond the ends of the crossties before beginning the 2:1 downward slope. Manual M.W.1 recommends ballast for welded rail track be flush with the tops of the crossties to a point 12 inches beyond the ends of the crossties before starting the 2:1 slope. This provides additional weight at ends of the crossties and additional insurance against ballast dropping away from ties under outside influences. It also widens the entire ballast bed by 6 inches on each side, a total of 1 foot. It is recognized that, under the operating conditions, the sharp break between level ballast and the slope is an unstable configuration and will tend to round off under use.

The level of the ballast where the track buckled varied from flush with tops to 3 inches below the tops of the crossties. Figure 1 on page 6 clearly shows that the ballast in the intertrack space does not meet the recommended standard for ballast in either C.E. 78 or M.W.1. This photograph was taken on May 26, 1969, and no ballast was added between that date and June 28, 1969. The tops of rails of the Nos. 2 and 3 tracks north of the crossing were at the same level. It is apparent from the photograph that the ballast left much of the ends of the crossties of No. 2 track exposed, which is an indication that a similar condition existed for the east end of the ties on No. 3 track. The ballast was not flush with the ends and did not extend outward in the level configuration for any distance. This condition was also observed by Safety Board personnel on the day of the accident. There is no indication that the amount of ballast below the bottom of the crossties was deficient. However, there is some doubt about the density of the ballast below the crossties. At the time when the crossing was rebuilt, new crossties were installed north of the crossing; the track was raised about 1 1/2 inches and tamped with an on-track mechanical tamper. Shortly thereafter, on April 16, 1969, it was necessary to retamp the track north of the crossing because it had settled. This tamping was done by hand with tamping picks. In this operation, the track was not jacked up but the crossties were tamped raising them tight to the rail. No additional ballast was added so that the effect was that the ties rose in the ballast, reducing the amount of ballast coverage. That reduced the frictional forces on the sides of the crossties and the weight resistance at the ends of the crossties.

Pick tamping is an inexact operation, the final quality of which depends upon the ability and experience of the trackman doing the work. Although ballast can be tamped under a crosstie tighter with a tamping pick than with a mechanical tamper, the total result lacks consistency. After several weeks, this can result in an uneven surface. If this occurred at Glenn Dale, the effect of a train going over the track, moving the rails up and down while it was under severe compression, would tend to induce buckling.

The compressive forces in the welded rail of No. 3 track north of the crossing were increased by the rail's tendency to creep southward because of the predominant southward flow of traffic and the descending grade. The wavelike action generated ahead of the locomotive wheels. was interrupted by the grade crossing. With the crossing's tendency to interrupt the wave action of the rail, the compressive forces concentrated in the track just north of the crossing.

It is not known to what extent the boring under the track affected the stability of the track while it was under the large compressive forces. The voids created by a 6-inch auger in boring a hole under a track usually are greater than 6 inches in diameter because of loose material from above, which constantly falls into the opening from vibration during boring. The openings left by the unsuccessful borings and the void around the 2-inch conduit would become filled by material vibrated from above by the passing of trains. This affected the relative density of the ballast section at that point; however, the degree of the effect cannot be determined. There was no evidence that the track sagged but this influence could have been a contributing factor to the track's buckling.

Although it cannot be confirmed that the misalignment noted by the OHSGT engineers was a causal factor, its possible effect should be considered. The small misalignment would have started lateral movement of the cars which, with the high axial compressive stress along the direction of the tracks, induced buckling of the track. Once the buckling started, the movement of the trucks following the slight buckling would have increased the lateral shaking force while the compressive force was still present and aggravated the buckling until the misalignment became great enough to cause derailment. Even without the lateral shaking forces, a rail under severe compressive forces would tend to buckle at a point of misalignment before it would at other points.

Track tends to lift in a wave motion in front of the weighted wheels of a train and lateral resistance through contact between the bottoms of the crossties and the ballast is momentarily reduced during this lifting. During such periods, most of the restraint to lateral movement is exerted by the ballast between and at the ends of the crossties. The reduction in lateral resistance by lifting is normal, but it could become an initiating factor if the ties already have reduced lateral resistance because of low ballast and the rails are in high compression. These problems existed just before the Glenn Dale accident.

The deduced sequence of action can be described. The locomotive and head cars passed over the point of derailment with no observable indication of the track's being out of line, but the misalignment would have produced some lateral movements of the trucks to shake the track laterally at the same time that the track was being shaken vertically by the normal wave motion. At that time the movement of the tracks was restrained by ballast to a lesser degree than normal and a lesser degree than specified in the Manual M. W. 1 recommendations. The ballast restraint may also have been reduced to an unknown degree by the lesser density implied by the subsurface borings. The shaking of the track in both directions resulted in initial buckling under the compressive force in the rails due to thermal expansion and train movement. This initial buckling in turn increased the lateral shaking by the movement of the trucks, producing further buckling. The process continued until the curvature in the rails became so great at a point near the grade crossing that the wheels could no longer follow the track. The derailment followed, and progressive destruction of the track led to the general derailment.

In this group of factors which led to the initial derailment, the boring was unusual, but is not alone considered a hazard to normal track unless some direct damage is done. The restraint offered by the ballast is not now subject to calculation, but it was substantially below that which would have been provided by the full ballast section as required by Manual M.W.1.

The design of track should be such that there is a margin of safety to cover cumulative environmental or operating conditions and the possible reduction in efficiency of one or more components which make up the track. The margin against buckling may have been exceeded by changes in any of several factors. Whatever the change, the degree of the change was not very large, because a similar passenger train had been over this track within 15 minutes before the accident and any of the conditions present could have changed but little in the available time.

The one factor which could have substantially raised the margin against buckling is the maintenance of a full, properly maintained ballast section. Had such a full ballast section been present, the small changes in conditions which occurred over a 1-hour period could not have been sufficient to have exceeded the added resistance to lateral movement which would have been provided by a full ballast section. Thus, had the track in the derailment area met the Penn Central's requirements for a full ballast section, the track would probably have stayed in line under the influence of the high temperature and other factors discussed above. It should also be noted that the 100° temperature at the time of the derailment and the intensity of the rays of the sun were at their peak at approximately the time of the derailment.

According to a witness from OHSGT, the track standards in the contract with the Penn Central were comfort standards, not safety standards. Witnesses from the Penn Central Company said that safety standards for track condition in general were a matter of judgment, and indicated that conditions considerably below those of Manual C.E. 78 were acceptable to them from the standpoint of safety. It appears that the contract for the Northeast Corridor is being interpreted to require standard for comfort only. There are no minimum standards to meet safety needs which do not affect comfort.

It is possible for one of the components of good track, such as rail, to have a serious flaw affecting the safety of the track and not affect the comfort of the ride before actual failure occurs. Transverse defects in rail, for example, could fail in service before affecting the ride quality.

On October 21, 1969, the Safety Board recommended to the Federal Railroad Administrator that ". . . the contract be interpreted to adopt, as criteria for judging contract fulfillment of track safety under Section XIV B., the literal standards of the Penn Central Company's Manual of Standard Practice for Construction and Maintenance of Track, M.W.1 . . ." The Safety Board's complete recommendation in this matter is found in Appendix 3.

Observations of the ballast shortages were made by Safety Board personnel during the investigation, and were confirmed by other surveys of nearby track. This caused concern for the safety of the track used by the Metroliner during the period of high summer temperatures. (See Appendix 4.) On July 18, 1969, the Safety Board recommended that the Penn Central Company "inspect all of its track in the Washington-New York Corridor and in other areas where welded rail is installed to insure that a full ballast section as described in Penn Central Plan 70003 is present, and that a full ballast section be provided where deficiencies are found." Additional ballast was added to the welded rail track in the Glenn Dale area shortly after the accident and after the Safety Board's recommendation, bringing the ballast up to the manual-recommended level.

As the result of similar accidents in England involving continuous welded rail,[2] tests were made in which it was found that certain welded rail changed its stress characteristics in the course of service. Continuous welded rail was cut at 60 places in order to check the stress-free temperature. Measurements made at 43 of those sites show that the stress-free temperature was less than the planned temperature by amounts varying up to 27° F. with an average of 9° F. The British test report concluded that the long-term effect of rolling wheels of passing trains in cold weather could reduce the stress-free temperature of the rails. This effect would greatly increase the compressive forces at temperatures experienced on hot days. It should be pointed out that this is one way to explain that particular scientific observation. It has not been confirmed in other ways.

Penn Central officials stated that they could not guarantee that the track would not buckle again at Glenn Dale, even after repair. At this time, there is no way, except by guessing based on experience, to determine when buckling of a rail is imminent. The railroad industry needs badly a portable stress measuring device which would give instant readings of compression or tension in a rail without disturbing it. The tendency to buckle could be handled by frequent destressing and adjustment of the rails as the temperature changes; however, this would involve considerable expense and interruption of service, and might not be practical. It should be noted that although the provision of a full ballast section raises the margin significantly, it is still not known exactly where the buckling level will be found.

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[2] Ministry of Transport, Railway Accident, Report on the Derailment that occurred on 12th June 1968 at Berkhamsted in the London Midland Region, British Railways.

B. Derailment

When the derailed cars veered off the roadbed toward the west, the coupler pulled out of the rear of the 12th car. The draft stop probably failed when the 13th car and the rear of the 12th car veered from the normal line of the track, putting a torsional load on the draft stop on the left side greater than the stop could withstand. Added to that torque was the drag of six rear cars in a derailed condition digging into the crossties and ballast. On tangent track, with all wheels on the rails, there is no possible origin of forces capable of causing a draft stop to fail in that manner.

The initial derailment occurred to the left (eastward) in the direction of travel so that the west welded rail was initially a barrier between the car wheels and the downhill slope which led to the massive catenary supports. The east rail overturned and remained east of the wheels. However, both welded rails overturned under the forces generated and, with structural integrity of the track gone, the ties and ballast were churned into a confused mix. This result is visible in Figure 5, page 22. The west welded rail continued to exert some lateral restraint because it did not break and remained anchored to the track structure at points beyond either end of the torn up section. The effect might be likened to a bowstring.

It can be seen from Figure 4 on page13 that the restraint of the welded rail on the west side also played a significant part in keeping the cars in line with the track structure at a second point. This illustration clearly implies that some derailed cars on the front part of the train had moved down off the track structure toward catenary supports during the slowing of the cars but were restrained and led back up to the structure and thereafter remained on the track structure. In the illustration the movement of the cars was toward the viewer.

The key factors in making this safe result possible at this second point were the use of welded rail and the fortuitous circumstance that auxiliary support rails were present above a sewer excavation (Figure 4 page 13), the use of locked center pins on the trucks which kept them in place, and the limitation against misalignment of the trucks. The support rails served to hold a number of adjacent ties together as a unit, apparently stabilizing the ties and the track against the lateral forces being experienced. The welded rail was being removed from the track structure, almost tie by tie, by the train wheels as the wheels progressed. This action stopped at the point where the support rails held several ties together and simultaneously prevented lateral movement of the train wheels. This retaining action on the part of the welded rail was made possible by its welded construction. It is believed that bolted rail sections in this same circumstance would have exhibited many failures and would have shown no retaining action.

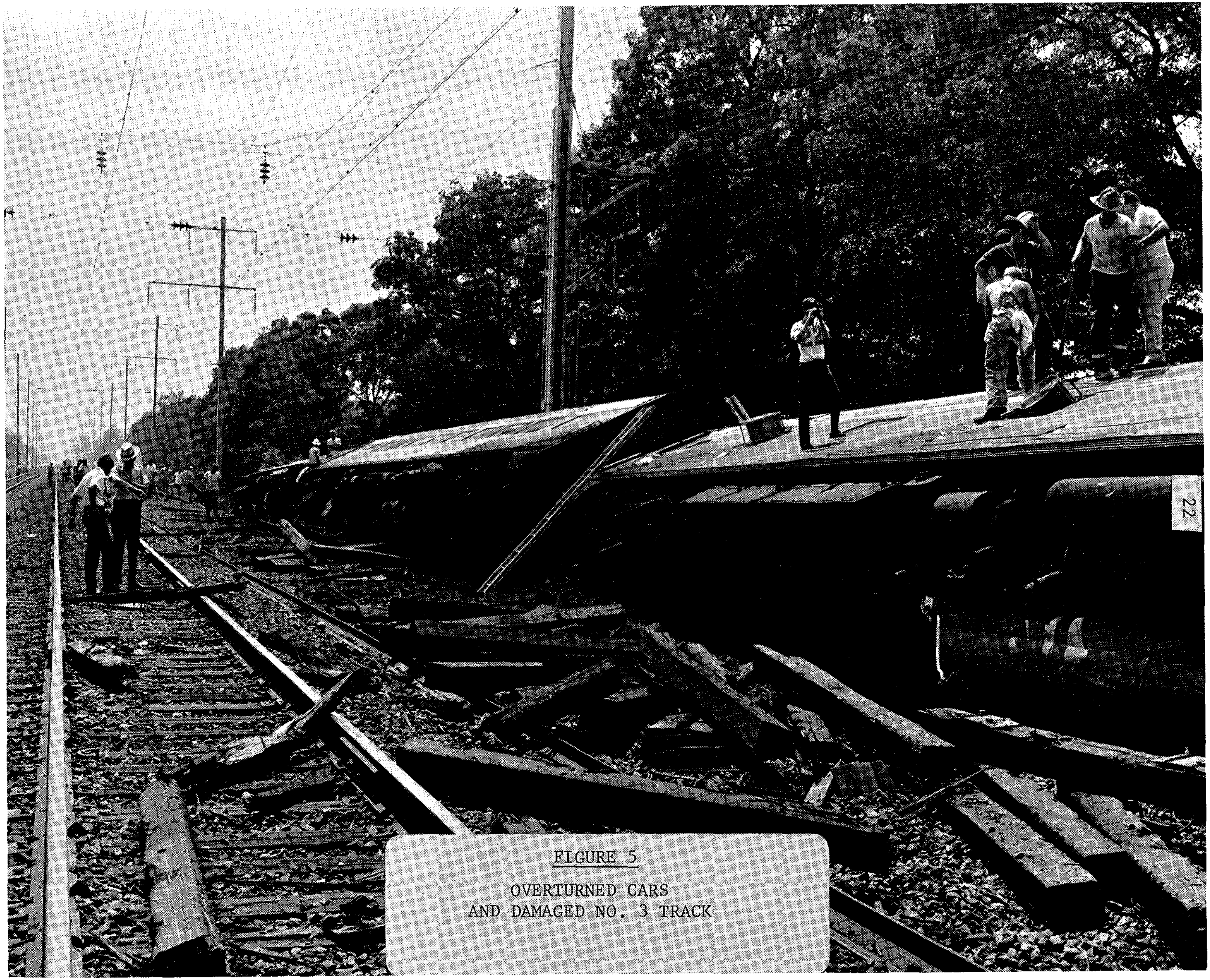


FIGURE 5

OVERTURNED CARS
AND DAMAGED NO. 3 TRACK

The east rail broke in a weld about 166 feet south of the point of derailment. An analysis of the broken rail led to the conclusion that the break resulted from lateral pressure (bending) on an incomplete weld. Tension and torsion were also present. The forces required to break the rail in that manner could not be generated by the cars when they are on the track. The lateral pressure probably came from the derailed wheels, some of which were running in the web of the rail.

Examination of the broken rail indicated clearly that about two-thirds of the area of the head had not fused to any significant degree during the welding cycle. The lack of fusion was attributed to poor rail end preparation and non-uniform heat distribution around the rail head during that particular weld cycle.

A magnetic particle test of the incomplete weld was made at the time of welding but did not indicate the presence of a surface crack. A possible explanation for the lack of crack detection may be the presence of flame-washed material resulting from post-weld finishing operations which filled in or sealed the surface of the crack. An in-track test by the Sperry rail flaw detector recorded the same indication for the incomplete weld as for a complete weld. It would appear that the material reached a temperature necessary to produce fusion, since sufficient upset occurred to allow the weld to be partially completed, but part of the surfaces did not fuse. It appears that there is no way to detect such incompletely fused weld except by a tensile test before installation or by devising some new test which would reveal the brittleness factor.

It was estimated by an engineer from Linde Division of Union Carbide Corporation that 2 percent of all the rail welds made by this process exhibit such incomplete fusion. He gave the opinion that the tensile strength of an incomplete weld was approximately the same as a complete weld but its ductility was much lower than in normal rail weld. The word "brittle" is normally used to describe the combination of poor ductility accompanying any level of tensile strength.

Railroad accidents due to this partial fusion are an unknown quantity because routine reports do not describe that condition. They have at least not been so outstanding as to attract attention heretofore. If there is in fact no significant problem of failure of partially fused welds in actual service, it would be wasteful to attempt to find the 2 percent of partially fused rails which are already in place in track. The Board believes that it is practical to make a detailed study of such failure experience because of the large amount of such welded track now in service, the existence of past accident records, and the possible possession of records of partially fused rails by industry.

It should also be noted that the unfused area served as a stress concentration in the edge of the properly fused area, in that a very high unit tensile strength would be placed upon the first fully fused grains adjacent to the unfused area. This condition could result in a failure of rapid progression similar to those which have caused ship hulls or pressure tanks to separate completely after origination at a very small crack.

The east rail overturned to the east, and a number of wheels ran on the web of the rail; however, any possible bowstring restraining effect from this rail was lost when the partially fused weld fractured, as can be seen in Figure 6. The fractured east rail remained in place and is somewhat to the east (left) in its original position. If this rail had exhibited significant restraining effect against the movement of the train off the track structure, it is believed that it would have been displaced to the west. Such displacement was shown by the rail which did not fracture.

The departure of the cars down the side of the roadbed appears to have begun at a point south of the failure of the east rail, that is, after the point of failure. Until the time that the movement down the slope began, the coupled train at all points forward of the derailment zone was in tension. When the draft gear pulled out, the tension on the front of the 13th car disappeared, and the front of the car dropped down the slope by gravity and overturned on its right side.

The draft gear in the other rear cars did not fail, and thus several of the cars overturned in sequence following the first car. They slid forward, decelerating in the torn up roadbed at a much greater rate than if they had remained upright on the track. The roof of one car passed a catenary support base at a distance of 1 1/2 feet and the first three cars were aligned so close to the massive concrete and steel structure that an equipment box door on the pole could not be opened because of interference. It is not possible definitely to credit the lateral resistance of the rail with having prevented these cars from striking the catenary support; however, the welded rail definitely resisted movement in that direction in some degree.

The cars which overturned passed very close to the upright members of the catenary system. These upright members are 14-inch standard, steel H-beam sections weighing 87 pounds per foot, buried in concrete and guyed to the outside with a woven steel cable. The lateral support members of the catenary system are stretched between these upright members, which are erected on opposite sides of track.

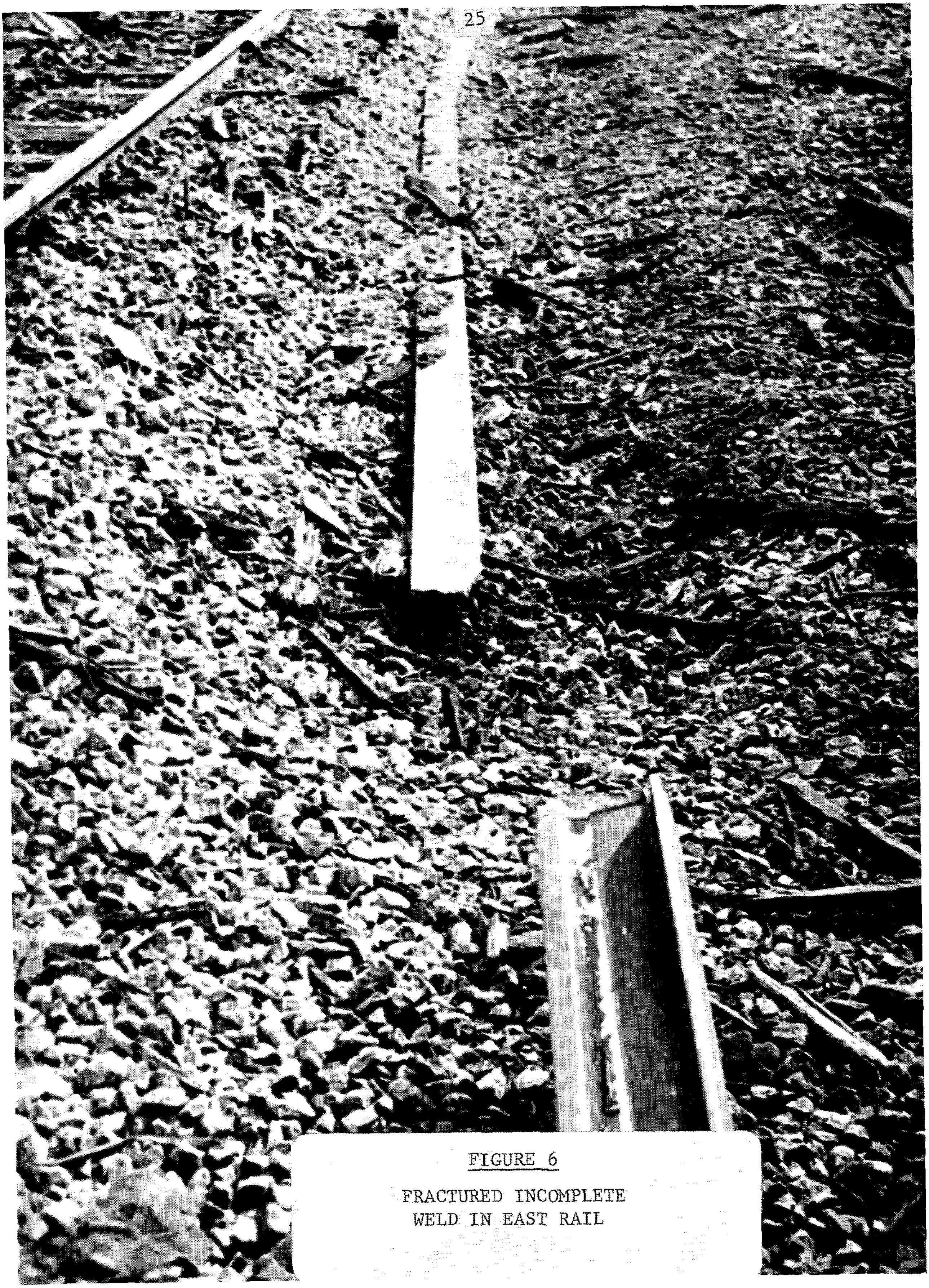


FIGURE 6

FRACTURED INCOMPLETE
WELD IN EAST RAIL

This accident could have happened to the Metroliners, which are authorized to run 120 miles per hour through Glenn Dale. The energies arising from trains on impact at a running speed of 120 miles per hour must be dissipated in the same manner as energies arising at only 80 miles per hour. However, these energies for cars of the same weight are more than twice as great at 120 miles per hour as at 80 miles per hour.

Past experience indicates that collisions of freight cars with these structures result in serious damage to the cars and contents. Fortunately, there have been no serious collisions of occupied passenger cars with these structures. In the Metroliner cars, the engineer's operating compartment is in the front vestibule, and it has very little crash protection. A collision of a Metroliner with a catenary pole at high speed would probably produce very strong direct impact upon the engineer's compartment and very high decelerative forces upon the car as a whole. A side collision between the lighter side structures of the car and the massive H-beam would threaten the structural integrity of the passenger compartment. Therefore, some means of restraining derailed cars on the track structure is important. The lesson that welded rail can have a strong restraining effect is apparent in this accident. It is also clear that a greater restraining effect is obtained where the rails and crossties can be held together as a structure.

The evidence regarding injuries and car design is not comprehensive enough to identify the causes of all injuries. However, two interesting and important questions are raised by this accident: the question of control of loose furniture and luggage on high-speed trains, and the question of the availability of some means of restraining passengers in their seats, should they desire to use it. In the aviation field, both luggage retention and seat belts are provided and required by regulations.

IV. CONCLUSIONS

(The page number after each conclusion relates that conclusion to the facts and analysis which led to it.)

1. Penn Central train 2nd 115 was being operated at the time of the derailment in compliance with all applicable rules and regulations. (Pages 2, 3)

2. The initial derailment occurred immediately north of the Glenn Dale Road Crossing when the track moved laterally beneath the train. (Page 8)

3. The buckling of the track was the result of a number of contributing factors in addition to compressive forces from heat expansion. (Pages 15 to 20, incl.)

4. The ballast section at the point of derailment did not comply with the Penn Central Company's recommended ballast section for welded rail track. (Pages 4, 17)

5. Most of the trains using No. 3 main track were southbound. (Page 7)

6. A contractor performed work beneath high-speed passenger tracks without constant supervision by a railroad inspector. The manner in which the work was performed could have damaged the track or a passing train. (Page 5)

7. The emergency brake application was the result of the separation of the train. There is no evidence that the brake application was a causal factor in the initial derailment. (Page 9)

8. The rail which broke in the weld was a result of the derailment and was not a causal factor in the initial derailment. (Pages 12, 23)

9. Although the continuous rail at Glenn Dale was welded by an approved method and the rail met A.R.E.A Specifications, the weld which failed was incomplete and defective. That incomplete weld was not detectable by existing rail flaw detector methods. (Pages 23, 24)

10. Rail welded by the oxyacetylene pressure butt weld method typically contains about five incompletely fused and therefore defective welds per mile of track which cannot be detected by any of the present testing methods. (Page 23)

11. The welded rail played a significant part in keeping the derailed cars in line, however, the amount of lateral restraint provided by the rail is not known. (Page21)

12. The use of welded rail appears to offer great potential for containing the effects of derailment at high speeds. The full potential might not have been achieved in this accident because of the rail fastenings. The system of attaching rails to ties by spikes offers highly variable resistance to derailment forces. (Page 21)

13. The coupler pulled out of the rear of the 12th car because of high stress being placed on a draft stop on one side of the center sill. (Pages 9, 21)

14. During the derailment, the cars were led downward off of the track structure and toward the heavy catenary supports by the normal design of the track structure which employs a slope downward toward the outside. (Page 21)

15. The cars were equipped with tightlock couplers and the trucks were held on by locking pins, preventing the uncoupling of couplers and the loss of or excessive slewing of trucks after the derailment. This prevented jackknifing of cars, and helped to maintain the cars in alignment after the derailment. (Pages 3,8,9)

16. The fortunate location of the Glenn Dale Fire Association's firehouse, and the timely alarm by its duty officer, resulted in an immediate and effective rescue operation. (Page 14)

17. The train and engine crews performed their duties after the derailment in compliance with Penn Central rules. (Page 5,7,8)

18. Most of the injuries resulted from persons' being thrown from their seats and from flying luggage and loose objects. The use of some type of body restraint by the passengers might have prevented many injuries. However, evidence relating injuries to car design is not comprehensive enough to draw conclusions as to the relative importance of the various factors. (Pages 14, 26)

19. The contract between the Office of High Speed Ground Transportation and the Penn Central Company does not adequately insure that the safety portion of the contract, as it relates to track conditions, will be fulfilled. (Pages 7, 19, 20)

20. The maintenance management approach found in this accident is one in which employees and supervisors determine what is "safe" and "unsafe" by personal judgment. This places a very high level of responsibility upon the individual employee and appears to make objective supervision of safety results of maintenance work difficult, if not impossible. (Pages 16, 20)

21. Although overturning forces are one of the most frequently applied forces acting on rails, the necessary or desired degree of resistance to overturning is unspecified in quantitative terms. This resistance is determined instead by design factors such as size of plates size of rails, and the number of spikes. The holding power of spikes, and therefore the resistance to overturning, is highly variable. (Pages 4, 12)

22. The identification of emergency equipment provided to assist people in escaping from damaged cars was hampered by the practice of painting the equipment and containers the same color as the walls of the car, thus effectively camouflaging the equipment. (Page 14, 15)

V. GENERAL CONCLUSIONS

This accident was a derailment involving the buckling of track used by high-speed trains in the Northeast Corridor project, which is generally considered to be the highest quality track found in the United States. The buckling did not occur under one of the high-speed trains moving at the 120-mile-per-hour authorized speed, but under another train moving at a much lower speed.

The investigation has revealed a number of contributing factors to the buckling, but it has not been possible to assign any specific outstanding role to any of them. The post-accident action of the Company in adding ballast to the levels indicated in Penn Central Manual M. W. -1, as recommended by the Board, served to increase the margin against buckling. It is also true that the margin against buckling would have been higher at the time the buckling occurred had the full ballast section been present; however, circumstances indicate the conditions had changed only slightly between buckling and non-buckling and therefore the margin against buckling was probably only slightly exceeded. Thus it is probable that the significant change of a full ballast section would have prevented the derailment.

The Board agrees with the witness of the Penn Central Company who said that he could not definitely state that this type of derailment would not occur again because the exact degree of resistance to buckling is unknown. Therefore, the threat of such a derailment is technically an unknown quantity insofar as the Metroliner or other trains operating at high speed on continuous welded rail are concerned. However, the Board believes that rail temperature is very important and that no threat of this nature exists except during periods of great variation in temperature. Further, because restoration of ballast is a significant change and because there may have been some deteriorating effect of the boring, the probability of buckling has been reduced. Thus, there is a risk of recurrence paralleling uncontrolled risks in other modes, such as the risk of midair collision.

A more significant conclusion for the long term is that the general state of the art of railroad track design and maintenance is scientifically weak, and that safety relies on judgment of individuals rather than on any firm and logical criteria. Legislation to provide authority to regulate track safety is progressing in Congress, and this accident may indicate that one of the early tasks in establishing worthwhile regulations would be to place track design and maintenance on a more analytical and mathematical basis, so that results can be predicted.

The examples in this accident indicate that the adequacy of railroad track design is judged by comparisons to other railroad track, not by necessary performance of track in relation with other parts of the system. Railroad industry witnesses have been unanimous in their praise of this type of track as being the best in the Nation, using the best materials and the most recent techniques when it was laid down in 1966. The rails are among the heaviest in the Nation, and the use of continuous welded rail is an improved technique, employing the best known welding process of the time. Despite the good reputation of this type track, it failed to perform adequately, buckling under a combination of operating conditions, none of which was considered hazardous.

The decision to make repairs was based on other track conditions, not performance of the train. Experts of the railroad company testified that the repairs had restored the track to its original desired condition, but they were not willing to say that it would perform in resisting future buckling. The reliance of supervisory and working maintenance personnel or individual judgment to determine whether track conditions and maintenance practices were safe also involves merely relative comparisons. The applicable manual, having absolute specifications, was not regarded as having a forceful effect, and safety became a matter of the interplay of opinion between employee and supervisor.

In the question of ability of the track to contain a derailment, it was suggested by this accident that the continuous welded rail is probably an improvement over the previous rail attachments, but no general goal or purpose of containing derailment and holding cars in line on the track structure could be found in railroad state-of-the-art documents. The improvement of the welded rail was only comparative, and it was an isolated improvement not part of an overall goal of resisting derailment effects. Other track problems, such as overturning of rail and pulling out of spikes, apparently did not allow full development of the potential retaining capability of the welded rail. Again, the state-of-the-art literature on attachment of rails to ties describes various methods, which can be compared visually with each other, but there is no indication of specific desired performance of any of them in resisting rail overturning. The requirements do not say what track is expected to do under conditions of derailment but rather how track is to be constructed.

This approach of describing track and maintenance by merely comparative methods, based also mostly on design of parts, is decidedly inferior to the method of specifying and requiring performance. Specification of designs tends to prevent the performance goals, such as containment of derailment, from being openly stated, and tends to prevent development of test methods which could provide assurance that the track will perform safely. If there is no requirement to perform, no test of performance will follow. Thus, in the long run, the use of design specifications alone leads to failure to find poor performance by tests, so that poor performance is discovered through accident reports, such as this one. (Design standards do have advantages, however, in field enforcement.)

The Board has noted exactly this same practice in its report of the tank car explosion castastrophe at Laurel, Mississippi, in which no full-scale test had been made of the ability of such tank cars to resist fire, and the accident provided the test which revealed highly undesirable tank car rocketing. In this Glenn Dale case, the Board does not know of any full-scale development tests that have been made in the railroad field to determine in detail what is likely to happen in derailment at very high operating speeds and what changes could best contain derailment. In other fields, full-scale crash tests of transport aircraft, buses, and other motor vehicles have been executed for more than a decade, and many changes have resulted.

The record does disclose electric strain gage tests of continuous welded rail to reveal stresses of the kind that influence buckling. These tests were ended, however, after failure of the electrical connecting wires, a minor development problem. As indicated in the report, there is a need for the railroad industry to solve this problem and to resolve the uncertainty of summertime operation in the Northeast Corridor.

In a sense, this accident could be looked upon as an unscheduled test and demonstration of the results of derailment, serving to indicate some problems which might follow a potential Metroliner derailment. Such derailments can also be produced by train equipment failures, derailment of other trains on adjoining tracks, or by striking vehicles at grade crossings. The conditions are significantly different in this accident from those in a possible Metroliner derailment. Speeds were much lower, producing only about one-half of the kinetic energy per car that would be produced by a Metroliner derailment at full speed. Despite these differences, the movement of these Glenn Dale cars down off the track structure and their close brush with direct and potentially disastrous impact against the massive catenary supports, carries a warning. High-speed derailment is subject to test or simulation, and analysis of this type of high-speed derailment should not be ignored.

The most desirable technical solution to this potential threat is not apparent. Full-scale derailment testing employing older equipment could be used to develop data. This approach has been used in the aviation industry. Considering that derailments are the most prevalent accidents, there appears to be a lack of information developed by the railroad industry concerning derailment factors in both freight and passenger service. Some advantages of welded rail in containing the equipment during derailments are evident in this accident, and testing would be expected to reveal more ways by which these advantages could be exploited.

This accident has also revealed the problem of partial fusion of gas-welded continuous rail, a phenomenon that is not generally known, although evidently known to those involved within the industry. This condition may well prove to be insignificant as a safety problem; nevertheless, it should be probed, as recommended.

VI. PROBABLE CAUSE

The Safety Board determines that the derailment was caused by lateral movement of the track under the train. The lateral movement was caused by buckling of the track.

The track buckled because of high compressive forces caused by heat expansion and the tendency of rail to creep in the direction of the predominant flow of traffic and descending grade. The absence of a full ballast section, irregular compaction of the ballast, and reduced density of ballast below crossties resulting from boring operations are possible contributing factors which could not be ruled out. A slight misalignment of the track produced lateral movement of the cars which may have initiated the buckling of the track, which was already under high compressive force.

A number of the injuries to passengers were caused by their being thrown from the seats and striking interior parts of the cars and by luggage being thrown about inside cars.

VII. RECOMMENDATIONS

(The number after each recommendation relates that recommendation to the conclusion which led to it).

1. The Safety Board recommends that the Penn Central Company require that main track with continuous welded rail be maintained to the literal standards of its Manual of Standard Practice for Construction and Maintenance of Track, M. W. 1. (Conclusions 3, 4, 6.)

2. The Safety Board recommends that the American Railway Engineering Association and the Association of American Railroads undertake studies to determine more accurately the stresses developed in welded rail track in extremes of temperature and the role of these stresses in hazardous track movements. (Conclusions 2, 3, 4, 5, 6.)

3. The Safety Board recommends that the Penn Central Company more closely monitor operations by nonrailroad personnel which might adversely affect the track or train operation. (Conclusion 6.)

4. The Safety Board recommends that the Federal Railroad Administration, in cooperation with the Association of American Railroads and the American Railway Engineering Association, conduct studies, including tests, to determine desirable combinations of track and equipment components required to act as a system to keep derailed cars upon and in line with the track structure. (Conclusions 11, 12, 14, 15.)

5. The Safety Board recommends that the Federal Railroad Administration initiate studies to determine the relationship between rail passenger car design and passenger injury and, where practical, take action for correction in the design of future high-speed and rapid transit passenger cars. (Conclusion 18.)

6. The Safety Board recommends that the Federal Railroad Administration initiate a review of railroad accidents involving failure of welded rail to determine whether failure of partially fused welds has been a factor in other accidents in the past. (Conclusions 8, 9, 10.)

7. The Safety Board recommends to the Federal Railroad Administration and the American Railway Engineering Association that research be undertaken to determine ways of effectively testing or otherwise detecting incomplete and defective welds of the types encountered in pressure butt welding and other newer methods of welding rails. (Conclusions 8, 9.)

8. The Safety Board recommends that the Association of American Railroads consider making rules requiring the use of emergency labels and contrasting colors for the painting of emergency tools, their containers, and the walls of the car so that the tools can be easily identified and their purpose understood. (Conclusion 22.)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

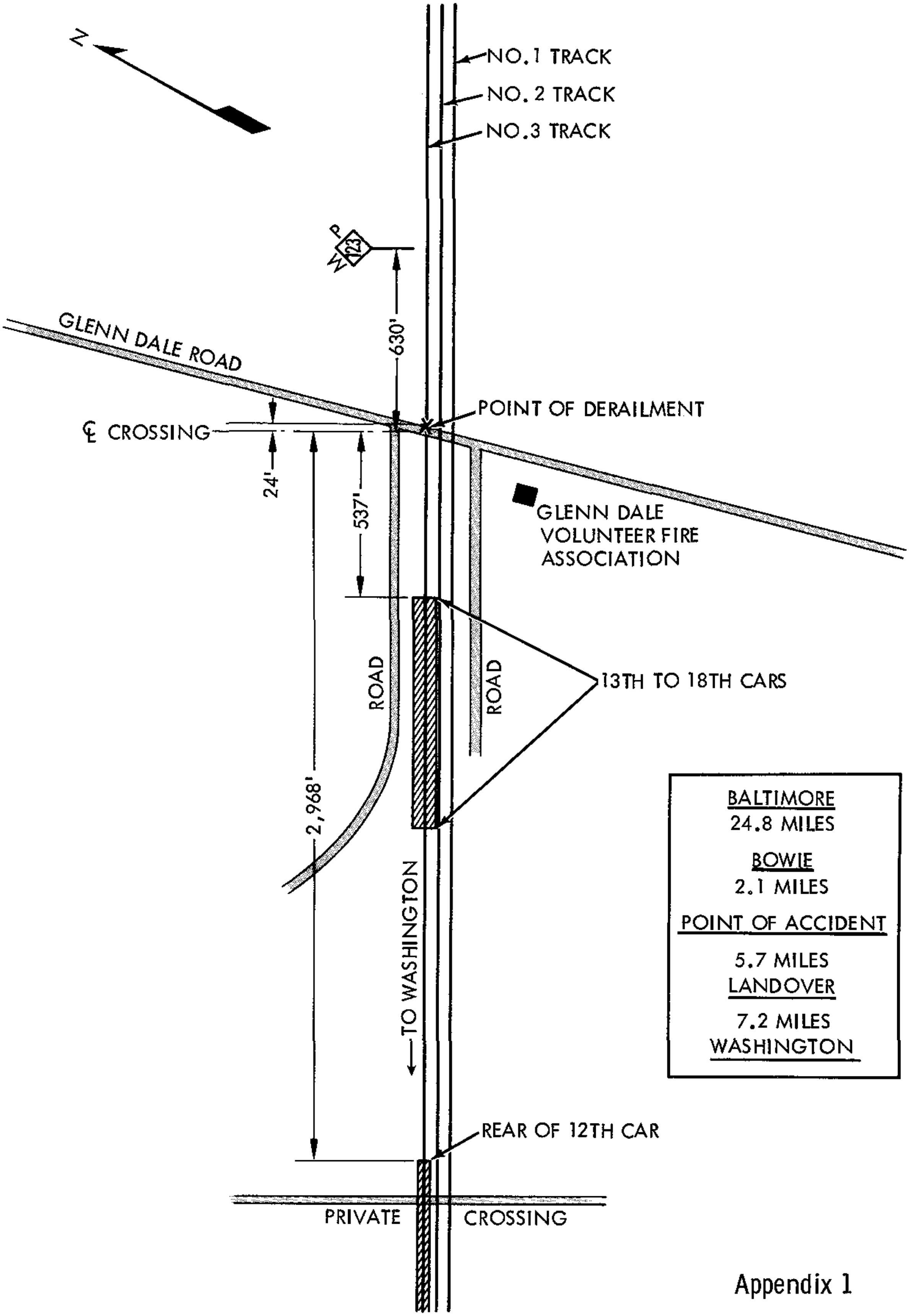
/s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

June 10, 1970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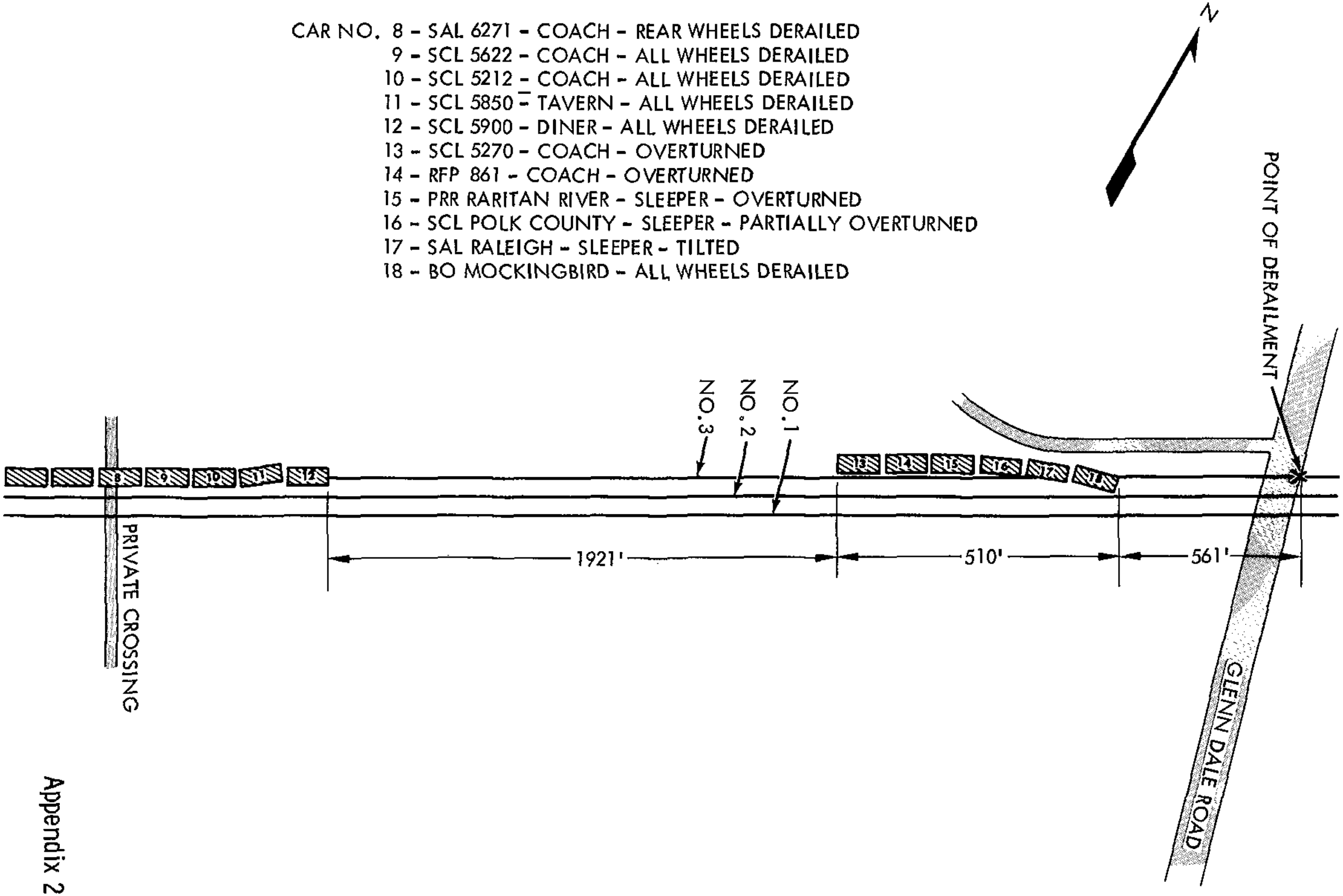
GLENN DALE
VOLUNTEER FIRE
ASSOCIATION
ROAD
ROAD
13TH TO 18TH CARS
2,968'
TO WASHINGTON
BALTIMORE
24.8 MILES
BOWIE
2.1 MILES
POINT OF ACCIDENT
5.7 MILES
LANDOVER
7.2 MILES
WASHINGTON
REAR OF 12TH CAR
PRIVATE
CROSSING

Appendix 1

Appendix 2



CAR NO. 8 - SAL 6271 - COACH - REAR WHEELS DERAILED
9 - SCL 5622 - COACH - ALL WHEELS DERAILED
10 - SCL 5212 - COACH - ALL WHEELS DERAILED
11 - SCL 5850 - TAVERN - ALL WHEELS DERAILED
12 - SCL 5900 - DINER - ALL WHEELS DERAILED
13 - SCL 5270 - COACH - OVERTURNED
14 - RFP 861 - COACH - OVERTURNED
15 - PRR RARITAN RIVER - SLEEPER - OVERTURNED
16 - SCL POLK COUNTY - SLEEPER - PARTIALLY OVERTURNED
17 - SAL RALEIGH - SLEEPER - TILTED
18 - BO MOCKINGBIRD - ALL WHEELS DERAILED

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

October 21, 1969

Honorable Reginald N. Whitman
Administrator
Federal Railroad Administration
Department of Transportation
Washington, D. C. 20591

Dear Mr. Whitman:

As you know, the Safety Board recently conducted a public hearing as part of the investigation of the Penn Central derailment at Glenn Dale, Maryland, on June 28, 1969. Testimony at the hearing revealed that the OHSGT contract with the Penn Central for the high-speed passenger train demonstration between Washington and New York relates track standards to a former Pennsylvania Railroad document. It also appears that although the contract provides that the railroad shall take proper safety and health precautions to protect the public, there is no basis in written documentation or standards by which OHSGT can insure that this safety portion of the contract, as it relates to track condition, is being fulfilled.

Article IV. B. 5. of the contract between OHSGT and the Railroad states.

x x x x

"B. The Railroad, at its own expense, shall:

5. Maintain the tracks regularly scheduled for use by demonstration trains to the following standards:

a. For authorized speeds up to 80 mph, the standards set forth in Railroad's Manual C. E. 78(J), Specifications for construction and maintenance of track."

Further conditions as to straightness of track for high speeds are also established. However, at the hearing, a witness from OHSGT said that these standards were comfort standards, not safety standards. Witnesses from the Penn Central Company said that safety standards for track condition in general were a matter of judgment, and some witnesses indicated that conditions considerably below those of Manual C. E. 78(J) were acceptable to them from the standpoint of safety.

In particular, whereas Manual C. E. 78(J) requires that ballast at the ends of ties should be brought up to the top of the tie at the end of the tie and for some distance outward from the end of the tie, Penn Central witnesses said they would approve for safety a much lesser condition. This condition was found near the scene of the accident in which ballast had dropped away from below the bottom surface of ties for a distance of about 12 inches inward from the end of two ties.

Section XIV. B. of the contract requires the railroad to take proper safety and health precautions to protect the public in the high-speed demonstration project. With reference to this provision, an OHSGT witness indicated that safety was entirely in the realm of the railroad and that reliance for safety was left with the contractor (the Railroad) by that provision of the contract. It appears that whatever the intent of XIV. B., this may be the de facto situation because no detailed safety standards are mentioned in the contract, or have been agreed to otherwise.

In the Glenn Dale derailment, Railroad witnesses agreed that the track had moved, but said they did not know why. The most responsible witness of the Railroad was not certain that the track would not move again after it had been replaced.

It appears to the Board that the contract is being interpreted so that the written standards have only a comfort purpose. Should practical considerations ever result in conditions dropping below these comfort standards, there are no minimum standards to meet safety needs which are far more important. Employees could allow ballast to drop from beneath ties in the same manner as was found near Glenn Dale, without any complaint being possible on other than a comfort basis.

The Board believes that Section XIV. B. of the contract should not be interpreted to free the railroad of any surveillance by government as to safety precautions, but that OHSGT is required, as a matter of insuring contract fulfillment, to determine whether the contractor's safety responsibility is being met, and to see that adequate margins of safety are actually present. This is particularly important because of the probable more severe consequences of a derailment at high speed.

The Board therefore recommends that, to insure a margin of safety, the contract be interpreted to adopt, as criteria for judging contract fulfillment of track safety under Section XIV. B., the literal standards of the Penn Central Company's Manual of Standard Practice for Construction and Maintenance of Track, M.W. 1. An appropriate understanding should be reached so that the Penn Central's M.W. 1 will apply to the high-speed passenger demonstration project.

The preface to M.W. 1, which states that the document is to ". . . serve as a guide . . ." and that it ". . . must be interpreted in the light of experience and the requirements of the service", vitiates its effectiveness as a standard. Therefore, this section should be removed before the Manual M.W. 1 is employed to interpret the contract. To insure that this document is usable as a basis for management enforcement of proper track maintenance, it is further recommended that the word "should" be replaced by "shall" wherever it appears in the standards. These changes will provide a basis by which the Government can determine that the track safety portion of Section XIV. B. is being fulfilled by the railroad.

The Safety Board notes that since the accident at Glenn Dale, track conditions near Glenn Dale have been improved by the addition of ballast, and appear to meet the ballast requirement of M.W. 1.

The effect of agreement between the Railroad and OHSGT to employ Penn Central's M.W.1 track-condition standards would be to supersede the requirements of Manual C. E. 78(J) where they appear in IV. B.5. of the contract. The M.W. 1 standards are a development of the C. E. 78 standard adopted by the merged Penn Central Company.

Our staff is available for consultation or for any assistance they may provide.

Sincerely yours,

(Original signed by
John H. Reed)

John H. Reed
Chairman

DEPARTMENT OF TRANSPORTATION
NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20591

OFFICE OF
THE CHAIRMAN

July 18, 1969

Mr. Alfred E. Perlman
President
Penn Central Company
230 Park Avenue
New York, New York 10017

Dear Mr. Perlman:

The National Transportation Safety Board has been conducting an investigation of the derailment accident to Penn Central Train Second 115, which occurred at Glenn Dale, Maryland on June 28, 1969. The investigation is continuing; however, some facts have been sufficiently determined to provide the basis for an accident prevention recommendation by the Safety Board to the Penn Central Company.

It has been determined that under conditions of high temperature, a section of track near the grade crossing at Glenn Dale moved laterally, producing a misalignment of the track. The ballast section in this area was less than that required under the Manual of Standard Practice for Construction and Maintenance of Track of the Penn Central Company, in that ballast at the ends of ties was not brought up to the level of the ties. This omission tends to reduce the degree of restraint against movement of ties in the lateral direction, and thus reduces the restraint against track buckling in high temperatures below that which would normally be provided by a full ballast section.

Since June 28, Safety Board personnel have inspected track in the vicinity of Glenn Dale and have found other instances in which a full ballast section at the ends of ties was not present.

Mr. Alfred E. Perlman   July 18, 1969

Because high summer temperatures tend to increase thermal expansion stresses in track, and because we are now in the midst of the highest temperature season, the Safety Board recommends that the Penn Central Company immediately inspect all of its track in the Washington-New York Corridor and in other areas where welded rail is installed to insure that a full ballast section, as described in Penn Central Plan 70003 is present, and that a full ballast section be provided where deficiencies are found.

Our staff is available to discuss this matter and to offer any assistance desired.

Sincerely yours,

(Original signed by
John H. Reed)

John H. Reed
Chairman

cc: Honorable John A. Volpe
Secretary of Transportation

Mr. Reginald N. Whitman
Federal Railroad Administrator