SS-R-36

RAILROAD ACCIDENT REPORT

COLLISION OF TWO PENN CENTRAL COMMUTER TRAINS AT BOTANICAL GARDEN STATION NEW YORK CITY JANUARY 2, 1975

ADOPTED: JULY 16, 1975

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D. C. 20594
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16.Abstract

This report analyzes a rear-end collision between two Penn Central commuter trains. The first train was moving at a speed of 15 mph when the engineer of the following train failed to stop at a "stop-and-proceed" signal and consequently collided with the train ahead. Four cars of the first train were derailed; damage to the cars was minimal. Two hundred and sixty-five persons were injured and three persons were hospitalized overnight.

The National Transportation Safety Board determines that the probable cause of the collision was the failure of the engineer of train 528, while operating the train in violation of the "stop-and-proceed" indication, to perceive the train ahead in time to prevent a collision; and the lack of a backup system to control the train in accordance with the signal indication when the engineer failed to do so. The cause of the large number of injuries in this relatively moderate collision was the poor design of seats and of other interior features.

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FOREWORD

The accident described in this report has been designated a major accident by the National Transportation Safety Board under the criteria established in the Safety Board's regulations.

This report is based on facts obtained from an investigation conducted by the Safety Board.

The conclusions, the determination of probable cause, and the recommendations herein are those of the Safety Board.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20594

RAILROAD ACCIDENT REPORT

Adopted: July 16, 1975

SYNOPSIS

At about 8:19 a.m., on January 2, 1975, Penn Central commuter train No. 528 passed a "stop-and-proceed" signal without stopping and collided with the rear end of commuter train 526 at Botanical Garden Station in New York City. Four cars of train 526 were derailed; however, damage to cars of both trains was minimal. Two hundred and sixty-five passengers and employees were injured. Three of the injured persons were admitted to the hospital and the others were treated and released. There were 34 fractures, 75 whiplash injuries, 51 nose lacerations, and many other facial lacerations. The trains were those of the Metropolitan Transportation Authority (MTA), which were being operated by the Penn Central under contract.

The National Transportation Safety Board determines that the probable cause of the collision was the failure of the engineer of train 528, while operating the train in violation of the "stop-and-proceed" indication, to perceive the train ahead in time to prevent a collision; and the lack of a backup system to control the train in accordance with the signal indication when the engineer failed to do so. The cause of the large number of injuries in this relatively moderate collision was the poor design of seats and of other interior features.

FACTS

The Accident

The Metropolitan Transportation Authority (MTA) is responsible for the suburban passenger train service on the Hudson and Harlem lines of the Penn Central Transportation Company (Penn Central). The MTA owns the commuter cars and has leased the right-of-way, including tracks, stations, and other pertinent fixtures, from the Penn Central. The MTA, in turn, has contracted with the Penn Central for operation of the service.

On January 2, 1975, Penn Central commuter train 526, which consisted of 10 self-propelled M-1 electric cars, was assembled in North White Plains yard. Prior to its departure, the brakes were properly tested. After making a stop at Hartsdale, it departed from Scarsdale at 7:59 a.m for Grand Central Terminal in New York City with 1,001 passengers aboard. The train passed Woodlawn tower at 8:12 a.m. and it was routed eastward on track 4.

Signal 1004, the fourth signal east of Woodlawn tower, displayed a "stop-and-proceed" aspect as the train approached. The engineer stopped the train short of the signal and he reported the signal's aspect by

radio to the operator at Woodlawn tower. The train was then moved eastward at about 15 mph in compliance with signal indication.

The next eastward signal, No. 954, displayed a clear aspect. When the first car of the train was about 53 feet west of this signal and the train was still moving at 15 mph, the rear of the train was struck by No. 528.

Penn Central commuter train No. 528, which consisted of six self-propelled M-1 electric cars, was also assembled in North White Plains yard. Its brakes were also properly tested before departing. After having made a previous stop, the train departed from White Plains, New York, at 8:01 a.m. for Grand Central Terminal with 547 passengers aboard.

Shortly after train 526 passed Woodlawn tower, a New Haven-to-Grand Central Station train arrived for movement through Woodlawn interlocking to track 2. The Woodlawn operator was unable to establish eastbound direction on track 2 for the New Haven train, and assumed that a signal problem was the cause. As train 528 was approaching Woodlawn tower, the Woodlawn operator requested the engineer by radio to observe the aspects displayed by the signals on track 2, which is adjacent to track 4, and if the engineer observed any "stop-and-proceed" aspects, to inform him. The engineer acknowledged this request. Train 528 passed Woodlawn tower at 8:15 a.m. and proceeded eastward on track 4.

The engineer of train 528 said that the only signals that he could recall which were displaying other than a clear aspect were those which governed the operation of his train on track No. 4. The first signal observed was at location 1084, which displayed an "advance-approach" aspect. Signal 1044 displayed an "approach" aspect and he reduced the train's speed to 30 mph. Farther east, the engineer recalled seeing a clear aspect being displayed by signal 1002, located over track 2, but he did not recall seeing the "stop-and-proceed" aspect displayed by signal 1004, which governed the movement of his train. Signals 1002 and 1004 are mounted 13 feet apart on the same signal bridge. According to the engineer, he attempted to report to Woodlawn tower the signal aspects he had observed on track 2, but he found the radio airways busy.

Train 528 consequently passed signal 1004 without stopping and continued eastward at a speed estimated to have been between 30 and 35 mph. The engineer said that he first saw the rear of train 526 after train 528 had moved around the curve east of signal 1004. At that time he thought train 526 was about four car lengths ahead of train 528. The engineer of 528 applied the brakes in emergency, but the train collided with train 526.

An assistant conductor on train 526, who was seated in the engineer's cab in the last car, was looking rearward as the train proceeded through the block of signal 1004. He observed the oncoming train as it moved around the curve, and even though he was unable to estimate its speed, stated that it was "closing in on us fast." In an attempt to warn the engineer of the

approaching train, he blinked the white lights on and off. When he realized that the collision was inevitable, he entered the passenger compartment and shouted a "brace yourself" warning to the passengers.

The engineer of 526 felt a severe impact to his train and he placed the controller in the emergency braking position. He did not know that his train had been struck until he was so notified by another crewmember.

The trains moved eastward 308 feet before stopping. Cars 5, 6, 8, and 9 of train 526 were derailed.

Accident Site

Traffic direction on the Harlem line from White Plains toward Grand Central Terminal is eastward. The New Haven line joins the Harlem line in the Woodlawn interlocking, 11.8 miles west of Grand Central Terminal, and the trains from both lines move toward Grand Central Terminal over a 4-track system. The tracks east of Woodlawn tower are numbered, from south to north, 4, 2, 1, and 3. Normally trains of the Harlem line use tracks 3 and 4 while those of the New Haven line use tracks 1 and 2. However, the interlocking is so arranged that any of the tracks can be used by either line between Woodlawn and Grand Central Terminal. Eastward trains on track 4 move around a 3°12' curve to the right which begins 231 feet west of signal 1004 and extends eastward for 1,365 feet to about the point of collision. The grade for eastbound trains is slightly descending. A bank about 12 feet in height and covered with brush parallels track 4 on the south. This bank somewhat restricts the engineer's view of a train ahead. Signal 1004 first becomes visible to an engineer of an eastbound train on track 4 when the train is 1,500 feet west of the signal.

The weather was clear with a temperature of 32°F at the time of the accident.

Method of Operation

Track 4 is signalled for eastward operation, track 3 for westward operation, and tracks 1 and 2 for operation in either direction, by an automatic-block signal system. No form of automatic train control is provided. The maximum authorized speed in this area is 60 mph.

The Signal System

Woodlawn tower controls only the signals governing movement through the interlocking. East of Woodlawn tower, the signals governing eastbound train movements on tracks 2 and 4 are of the colored, searchlight type and are lighted continuously.

Each signal consists of two units mounted one above the other with the top unit about 29 feet above the rails. The signals are located over

the tracks they control and are about 13 feet apart on the same steel structure. The signals are identified and located as shown in Figure 1.

The signal system is so arranged that when the block of signal 1004 is occupied it will display a "stop-and-proceed" aspect (red-over-red). A train must stop short of the signal and, after stopping, it may proceed into the block at a speed not exceeding 15 mph, prepared to stop short of a train, an obstruction, or a switch not properly lined. The train must be so operated until the entire train has cleared the block. The three signals to the west of signal 1004, if their blocks are unoccupied, will display the following aspects, and the carrier's rules require that trains will be operated as indicated:

Signal	Aspect	Name	Indication
1044	Yellow-over-red	Approach	Reduce speed to 30 mph and be prepared to stop at next signal
1084	Yellow-over-yellow	Advance Approach	Reduce speed to 45 mph and be prepared to stop at second signal
1124	Yellow-over-green	Approach Medium	Be prepared to reduce speed to 45 mph at the next signal

The direction of traffic had to be first established on track 2 before those signals would display other than their most restrictive aspect.

The Train Equipment

The cars in each train were self-propelled, electrically operated commuter cars locally classified as type M-1. They had recently been purchased by the MTA for operation on the Harlem and Hudson lines of the Penn Central.

This type of car is 85 feet long, of steel construction, and provided with 4-wheel motor-driven trucks; a third rail provides 660-volt d.c. electric power for its operation. An operator's compartment is provided on one end of each car. The cars are designed to be operated in pairs and each pair is semipermanently coupled together on the blind ends. The coupler on the cab ends is fully automatic. Each car is provided with dynamic and pneumatic braking systems which are automatically blended during normal brake operation. The cab ends are each provided with two white headlights and two red marker lights. When pairs are coupled for multiple unit operations, the engineer controls all cars from the operator's compartment on one end of the train.

Each car is provided with two doors on each side at quarter points, which can be operated individually or in conjunction with other side

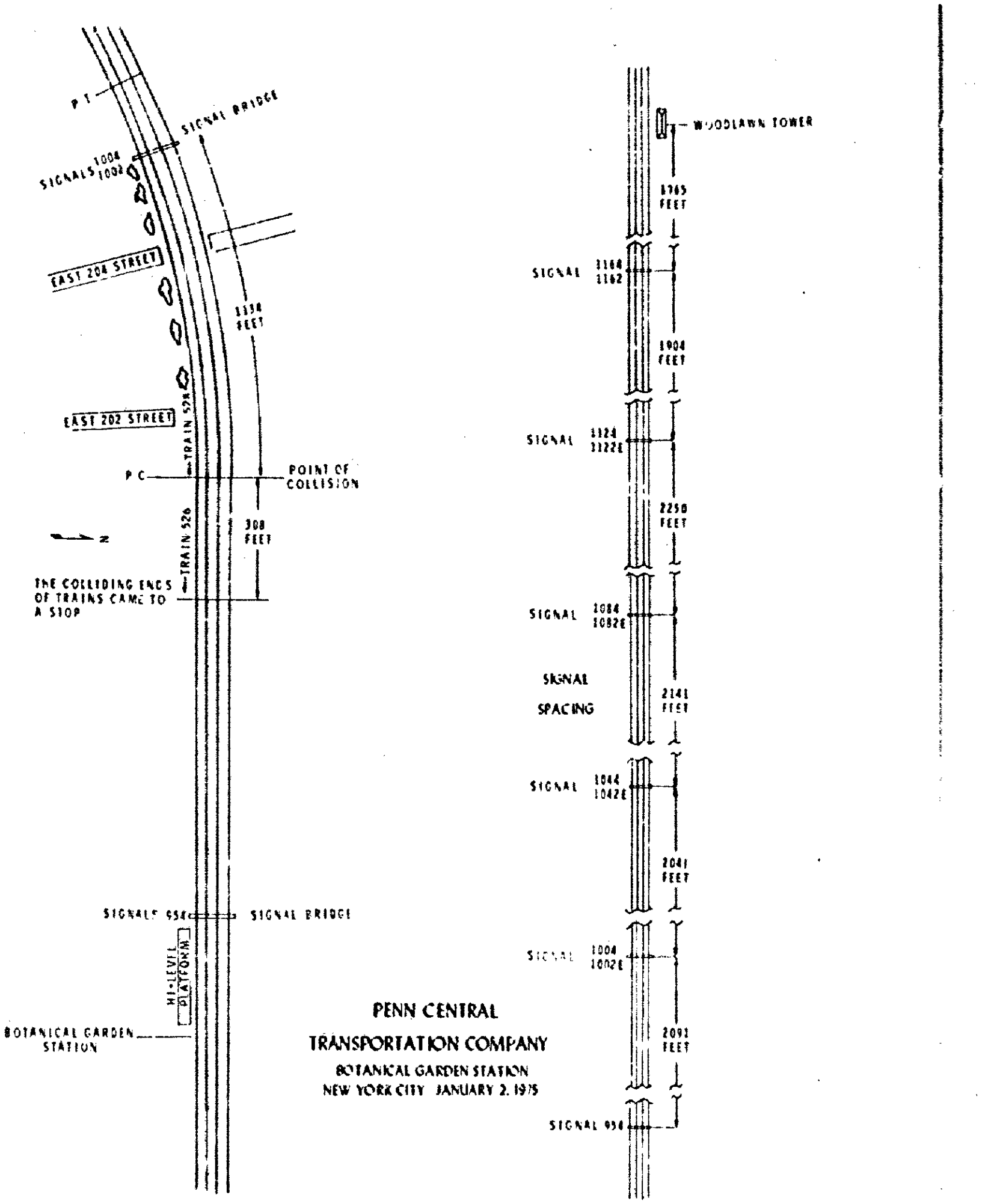


Figure 1. Sketch of the collision area.

doors from a control point in the train. Manually operated end doors are provided. The cars are designed for use at floor-level platforms and a wooden ladder is carried on each car for the emergency evacuation of passengers at other locations.

Each engineer's cab is provided with a radio for communication with other operating personnel and an intercom system is provided to make announcements throughout the train.

Details of the car's interior can be found in Appendix A.

The Engineer of Train 528

The engineer of train 523 was 65 years old on the day of the accident 1/ and had been operating trains regularly over this line during the past 20 years. He had been off duty for 12 hours prior to reporting for his assignment at 4:46 a.m. on January 2, 1975. He had completed one round trip between White Plains and Grand Central Terminal before assuming control of train 528.

The Penn Central requires that all engineers over 50 take annual physical examinations from a carrier-approved doctor. At the time of the accident, the carrier had no positive means of enforcing the requirement and relied on the employees for compliance. The employee was required to mark the date of his last physical examination in his timetable. The employees' timetables were checked on a random basis by officials of the carrier to determine if they contained all of the required information. No other checks of the physical examinations were made.

The engineer of train 528 had his last physical examination by a carrier-approved doctor in October 1965, according to the records of the Penn Central. The engineer claimed that he had lost his timetable in the accident, so his physical examination entry could not be determined. Officials of the carrier stated that they had checked the engineer's timetable during the past 2 years and had taken no exception to its contents. The engineer had had a physical examination in April 1974 for insurance purposes, but he was not approved because of high blood pressure. The doctor prescribed medication which reduced the high blood pressure.

Other crewmembers of train 528 stated that they took no exception to the physical condition of the engineer on the day of the accident and the engineer claimed that he felt normal. He declined to submit to a physical examination subsequent to the accident, and retired from railroad service.

Damage

Track -- The point of impact, 1,134 feet east of signal 1004, was determined from the location of a damaged third rail insulator of track

1/ On this portion of the Penn Central, engineers are required to retire at age 70 per terms of an agreement between the railroad and the labor union.

4 which had been broken by a sill step on the rear of the last car of train 526 when that car was depressed by the impacting force. The north rail was canted outwards for a distance of about 150 feet beginning at a point 355 feet east of the point of the collision.

Car Equipment -- There was little damage to the ends of the colliding train other than the broken coupler on the last car of train 526. The lights on the ends were not broken and the superstructure was not damaged. One or more truck bolster anchor rods were bent on each car of the two trains as a result of the impact.

In six of the cars in train 526, a total of 36 windscreens were broken and two cars had minor seat damage. Train 528 had four cars with windscreens damaged and three cars with minor seat damage. The estimated cost of the equipment damage was $38,500.

Postaccident Activities and Tests

Rescue Operations -- Immediately following the collision, railroad personnel notified the New York Police and Fire Departments. Rescue crews arrived at the scene about 15 minutes after the collision. The injured passengers and employees were removed to local hospitals for attention; 3 were admitted and 262 were treated and released. Some of the passengers stated that the rescue crews did an excellent job in the evacuation of the trains.

The first and second cars of train 526 stopped opposite the high-level platform of Botanical Garden Station following the collision. Most of the passengers in the forward portion were evacuated through the side doors of these two cars onto the platform. The passengers from the rear cars of 526 and from 528 were taken off the train by means of the wooden emergency ladders placed by the side doors.

Visibility and Stopping Distance Tests -- Tests determined that the rear car of a train standing at the point of impact would first become visible to the engineer of a following train at a point 552 feet east of signal 1004, or when the following train was 576 feet west of the rear car. Tests also disclosed that if the brakes of a train similar in consist to 528 were applied at the point of visibility, it would stop at the points indicated for the various speeds shown in the chart of Appendix B.

Tests of the Signal System -- Tests of the signal system following the accident disclosed that the three signals on track 4 west of signal 1004, when governed by signal 1004, displayed the intended aspects. Nothing was found that could have affected the continuity of the system.

Signals 1004 and 1002 were focused and had sufficient light intensity to be easily visible throughout the 1,500-foot distance in approach to the signals.

The tests did disclose that a rail lead from an impedance bond of track 2 within the block of signal 1002 had been struck by a previous train and was intermittently grounded to the north rail of track 4. This condition could cause signal 1004 to continue to display a "stop-and-proceed" aspect rather than a less restrictive aspect after an eastbound train had cleared the block of the signal. It also could prevent the selection of traffic direction on track 2. The grounded impedance bond could not have caused signal 1004 to display any aspect less restrictive than "stop-and-proceed" while train 526 was occupying the block of signal 1004.

ANALYSIS

The Accident

The "stop-and-proceed" aspect of signal 1004, which apparently was caused by the grounded impedance bond, disrupted the operation of train 526 and narrowed the interval between it and train 528. With train 526 accelerating from a standstill to 15 mph at signal 1004, and with train 528 closing the distance between the trains at a speed of at least 30 mph, it was inevitable that a collision would occur unless the engineer of train 528 comprehended the situation and prevented it. Failure to recognize the "stop-and-proceed" aspect of signal 1004 logically led to train 528's proceeding into that block without the engineer's specifically keeping a lookout for a train ahead or for some obstruction. Under that circumstance, it is not surprising that the engineer of 528 did not perceive train 526 as soon as the line of sight permitted. Possibly the flashing of the white lights by the assistant conductor who was riding the rear compartment of train 526 eventually alerted the engineer that 526 was ahead.

The fact that train 526 was moved ahead 308 feet, with its brakes in emergency and four cars derailed, indicates that train 528 struck it with significantly greater speed than would normally be expected if the engineer of train 528 had perceived train 526 four car lengths (340 feet) away. During the 11 seconds required to stop train 528 from 30 mph, train 526 at 15 mph would have moved eastward 242 feet, increasing the distance available for train 528 to stop. Thus, if the engineer of train 528 had perceived train 526 when it was 340 feet away and traveling 15 mph, train 528 should have been stopped before striking train 526. If the brakes had not been applied in emergency until the moment of impact, with the trains moving at the described speeds, it is doubtful if the trains would have moved an additional 308 feet. Thus it appears that train 528 was moving faster than 30 mph when the brakes were applied in emergency.

The engineer's action to reduce the speed of train 528 in compliance with the requirements of the "advance-approach" and "approach" aspects of signals 1084 and 1044 and his recollection of the clear aspects of the corresponding signals on No. 2 track indicate he had no problem with perception of those signals. The engineer's recollection that signal 1002, which was only 13 feet to the left of signal 1001 over track 4, was clear, and his failure to reduce speed suggest that he never perceived the "stop-and-proceed" aspect of signal 1004. The added task of observing the aspects of the signals over No. 2 track could not be determined to be causative. No reason for failing to perceive and act on the "stop-and-proceed" indication could be determined.

This accident illustrates the inadequacies of depending upon the engineer for compliance with signal indications without a backup system. A train control system on train 528 would have warned the engineer when he passed signal 1004 and would have applied the brakes if the engineer did not. The safety control which applies the brakes if the engineer releases the controller is not sufficient backup for the type of failure which apparently occurred in this case.

As a result of this collision, the Safety Board, on March 5, 1975, made two recommendations to the FRA concerning a backup braking system. (See Appendix C.)

Physical Requirements for Engineers

One can deduce from the requirement that all engineers over 50 years of age have an annual physical examination that the Penn Central recognized the importance of having physically fit engineers. However, it is difficult to reconcile that requirement with its almost complete lack of enforcement. It could not be determined from the engineer why he had not been examined by a Penn Central-approved doctor since 1965. Enforcement of the examination requirement by Penn Central might have discovered a condition that could have contributed to this accident.

Crash Injury Analysis

The low magnitude of forces produced in this collision was evident from the lack of damage to the colliding cars and the maintenance of structural integrity of the passenger compartments. Still, there were a large number of injuries.

When impact occurred, passengers in the struck train, half of whom were facing rearward, were thrown from their seats toward the rear while those facing forward were forced backward into their seats. Conversely, in the striking train, passengers facing forward were thrown from their seats and those facing rearward were forced backward into their seats.

Interviews by Safety Board investigators and a survey by MTA (See Appendix E) indicated that more than half of the injuries resulted from impact with the seats in front of passengers. There were 34 fractures, 51 nose lacerations, and many other facial lacerations caused by striking seat backs in front of them. (See Figures 2 and 3.)

The back and top edges of the seats were hard, molded plastic without padding. Effective padding would have reduced the number and severity of facial injuries. The metal ticketholder on the top of the seatback was so located that the face of a passenger, if thrown forward, would strike it. This hazard can be eliminated by a design change. (See Figures 4 and 5.)

There were a significant number of injuries to heads, necks, and upper backs. An additional number of injuries, reported as "head trauma," included 75 whiplash injuries. Figure 6 depicts how such an injury can occur to persons in low-back seats.

Whiplash and other upper back injuries probably resulted from the absence of head support. Figure 7 shows that the 24-inch seat back was insufficient to support the head of the average male. Human-factors data 2/ reveal that a seat back height of 34 inches will support the heads of the general population.

The aisle seat of each 3-seat group had several possible injury-producing features. (See Figures 4 and 8.) Because of the approximately 19-inch backrest, upper back and neck injuries could be expected from rear-end impacts. Where these seats are located back-to-back (See Figure 9) and face-to-face, passengers could be hurled into each other. The seat back was so low that passengers would be propelled over it. The metal bar and plate on the top of the low backrest could cause severe injury to face or head if a passenger were propelled into it.

When struck, the laminated glass panels in the upper parts of the windscreens shattered. Some of the glass panels had been replaced with plastic, but there were still many glass panels. Sharp edges of the metal frames mounted on the windscreens could lacerate passengers who contacted them. (See Figure 4.)

The overhead luggage rack (which had no means of restraining luggage), the metal edges of the window frames, and edges of the offset panels were undesirable injury-producing features. The injuries resulting from impact forces could be reduced in the future by effective padding and elimination of sharp edges.

Most railcar crashes result primarily in longitudinal forces. Many features, especially those of the seats, could be redesigned or altered to reduce serious crash injuries. (See Appendix D for past Safety Board

2/ Damon, Albert; Stoudc, Howard W.; McFarland, Ross A.; "The Human Body in Equipment Design," 1966 p. 313.

Figure 2. Manner in which nose injuries can occur on back of seat.

Figure 3. Manner in which face injuries can occur on grab bar of low-back seat.

Figure 4. A. Low-back seat with metal grab bar. B. Metal frames on windscreen. C. Metal overhead luggage rack.

Figure 5. Back of seat with arrow (A) showing location of metal ticket holder.

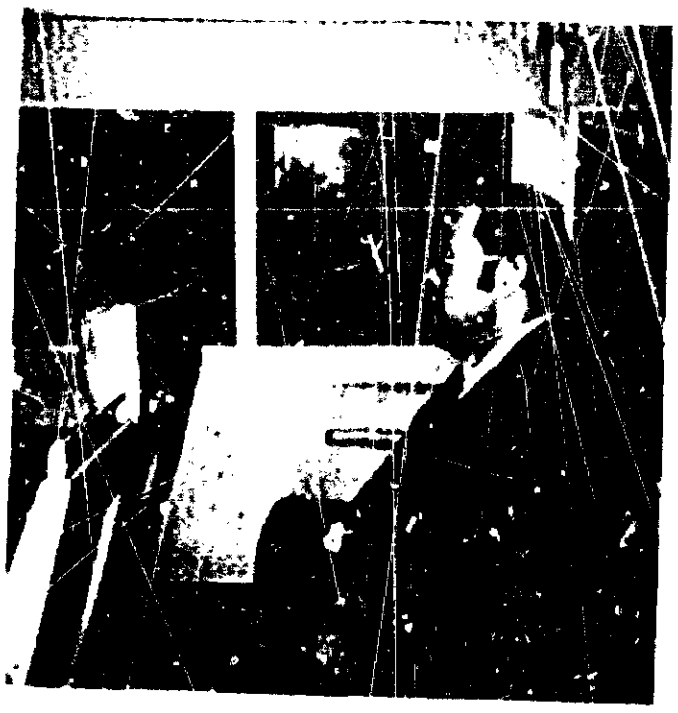


Figure 6. Seated position of occupant in low-back seat. Note no support for upper back, neck, and head.

Figure 7. Sitting height in relationship to back-rest height for a 50th percentile male.

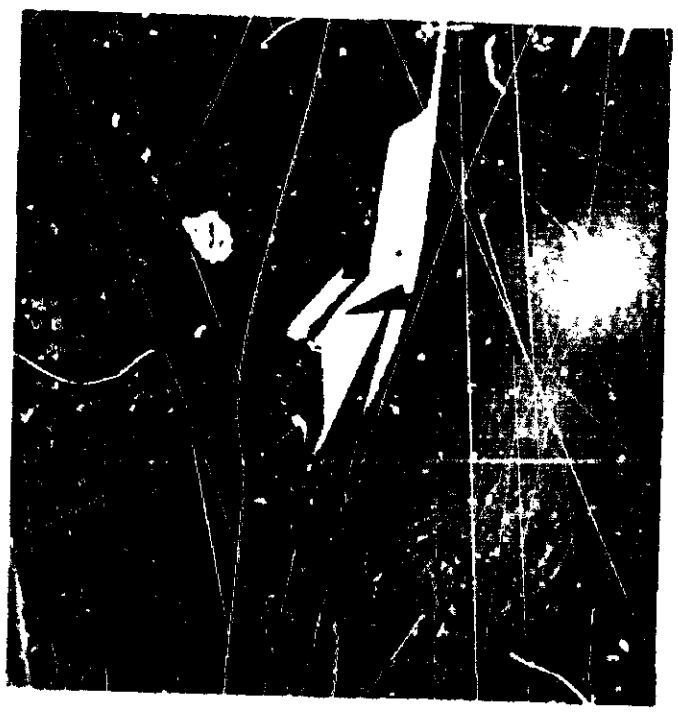


Figure 8. Hard armrest located on aisle seat.

Figure 9. Low-back seats installed back-to-back.

recommendations to the Federal Railroad Administration (FRA) concerning redesigning of injury-producing interiors of rail passenger cars.)

There are no regulations, at this time, which would eliminate the injury-producing features of railroad passenger car interiors and which would provide additional protection for passengers during crashes. Some changes have been made in materials of passenger car windows to reduce ejections. The car involved in this accident was designed and constructed long after the Safety Board recommended corrective measures to the Federal Railroad Administration and had called the railroad industry's attention to the need for improved designs for the car interiors.

CONCLUSIONS

1. Signal 1004 displayed a "stop-and-proceed" aspect, due to a grounded signal cable, when train 526 approached. The inability of the Woodlawn operator to establish traffic direction on track 2 was caused by this grounded signal cable.

2. The engineer of train 528 was able to discern the aspect of the signals over tracks 4 and 2 west of signal 1004. Due to their location, they could easily be observed from the control cab of an eastbound train on track 4. It could not be determined why the engineer failed to observe signal 1004.

3. Train 528 was not operated in compliance with the indication of signal 1004.

4. Train 528 was being operated at a speed faster than 30 mph as it proceeded eastward from signal 1004.

5. The engineer of train 528 did not perceive train 526 at the point where it first could have been seen by him.

6. The Penn Central failed to enforce their own regulations requiring engineers over 50 to have annual physical examinations.

7. If the commuter cars involved in this accident had been designed to eliminate the injury-producing features discussed in this report, the number of injuries resulting from the collision would have been greatly reduced.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the collision was the failure of the engineer of train 528, while operating the train in violation of the "stop-and-proceed" indication, to perceive the train ahead in time to prevent a collision; and the lack of

a backup system to control the train in accordance with the signal indication when the engineer failed to do so. The cause of the large number of injuries in this relatively moderate collision was the poor design of seats and of other interior features.

RECOMMENDATIONS

The National Transportation Safety Board previously made two interim recommendations to the MTA (R-75-6 & 7), which along with the reply of the MTA to this recommendation are contained in Appendix C.

Additional recommendations made to the Metropolitan Transportation Authority and to the FRA in Safety Recommendations R-75-34 to R-75-38 are contained in Appendix F.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JOHN H. REED
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

July 16, 1975

APPENDIX A

DESCRIPTION OF THE INTERIOR OF THE M-1 COMMUTER CARS

Two side doors are located on each side of a car as shown in Figure A-1. Each side door opening is provided with double sliding doors which are operated electrically. The door openings are spaced to provide equal access to each quarter of the car. All side doors on one side of the train can be operated from a control station, which first must be actuated by a key; an individual door can be operated from a switch mounted on an adjacent windscreen. The doors are locked when closed by the positioning of the mechanism's levers. Manual or emergency opening of the doors can only be accomplished by operating a release lever which is contained in an unmarked cabinet.

Windscreens are located on both sides of each door opening to provide protection for the passengers when the doors are opened. The top portion of the windscreen was originally provided with a laminated glass panel which is being replaced with plastic. A metal frame is mounted on the glass or plastic panel to carry advertising posters.

Five-abreast seating with offset aisles is provided as shown in Figures A-1 and A-2. The seats are permanently located so that passengers in the end quarters of the car face toward the center while those in the center quarters face the ends. In the center of the car two rows of seats are placed back-to-back.

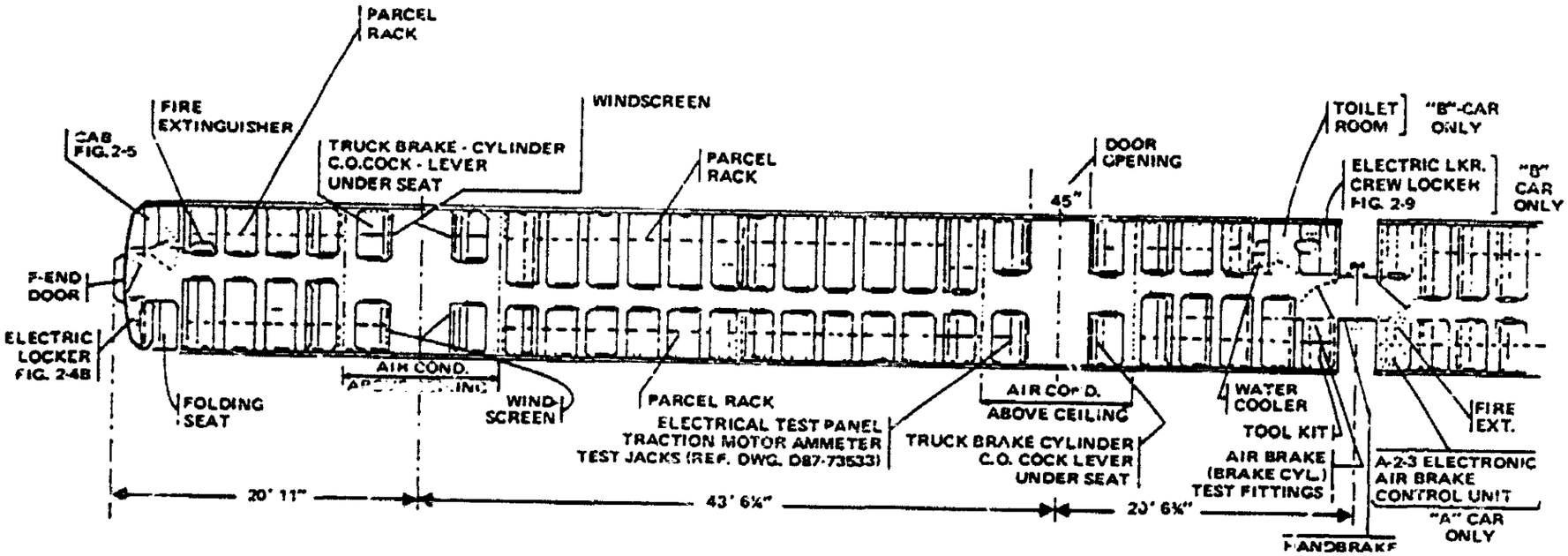
All of the seats, with the exception of the aisle seat of the 3-seat group, are classified as high-back seats. The tops of these seats are 24 inches above the seat cushion. The seat consists of a formed plastic shell with an upholstered cushion.

The inboard or aisle seat has a low back, the top of which is 19 inches above the seat. A metal bar is secured to the top of the seat and extends the full width of the back. This bar is used as a handhold for standees. (See Figure A-2.) The seat is constructed similarly to the high-back seat.

A metal ticketholder is mounted on the top of the seat back for each group of seats.

A luggage rack utilizing metal tubing is mounted on the wall above the windows along each side of the car. No restraints are provided to secure luggage or particles in the rack.

A fire extinguisher, emergency tools, and an emergency ladder are provided in each car.



FLOOR PLAN – "B" CAR (SEATS REPLACE TOILET ROOM IN "A" CAR)

Figure A-1. Floor plan, A & B cars; note tabulations.

Figure A-2. Overall view of seats.

APPENDIX B

STOPPING DISTANCE TESTS, BOTANICAL GARDENS

Consist of train: The test train included the following six which were the same cars assigned to train 528 at the t collision --

8269-8268
8201-8200
8251-8250

Weather: Overcast, rain, and sleet.

Method of Conducting Tests: A flag was placed at the point 526 would first become visible to the engineer of 528 a labeled "point of vision." Another flag was placed at t impact. The engineer of the test train was instructed t the required speed and apply the brakes for the various "point of vision." Time and distance were then measured ping point.

The distance between the "point of vision" and the point was 576 feet.

APPENDIX E

TESTS AND THEIR RESULTS

TEST	Point of Vision ← 576 Feet → Point of Impact ← 308 Feet → Rear of 526 after Collision DISTANCE TO STOP
No. 1. 30 mph - Emergency Application Time to Stop 11 Sec.	278 Feet.
No. 2. 35 mph - Emergency Application Time to Stop 12.5 Sec.	397 Feet
No. 3. 40 mph - Emergency Application Time to Stop 15.5 Sec.	510 Feet
No. 4. 50 mph - Emergency Application Time to Stop 21.5 Sec.	908 Feet
No. 5. 57 mph - Emergency Application Time to Stop 27 Sec.	1361 Feet
No. 6. 30 mph - Full Service Application Time to Stop 13 Sec.	312 Feet
No. 7. 45 mph - Full Service Application Time to Stop 19 Sec.	656 Feet
No. 8. 30 mph - Service Appl. to 55 lbs. Brake Cylinder Pressure Then Emergency Time 12 Sec.	294 Feet

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX C

ISSUED: March 5, 1975

Forwarded to:

Mr. D. L. Yunich
Chairman
Metropolitan Transportation Authority
1700 Broadway
New York, New York 10019

SAFETY RECOMMENDATION(S)

R-75-6 and 7

On January 2, 1975, Penn Central Commuter Train 528 collided with Penn Central Commuter Train 526 on the Harlem Line near Botanical Garden Station in New York City. The National Transportation Safety Board's continuing investigation has revealed several safety problems which the Safety Board believes warrant prompt corrective action.

Trains on the Harlem Line operate by signal indications of an automatic-block signal system. The signal system is designed so that a following train is expected to slow from a maximum authorized speed of 60 mph to 45 mph when an "advance-approach" signal is displayed two blocks behind a train ahead, slow to 30 mph when an "approach" signal is displayed one block behind the train ahead, and stop and proceed at "restricted speed" when a "stop-and-proceed" signal is displayed at the entrance to the block occupied by the train ahead. The wayside signals are not supplemented by any type of train control devices. Compliance with signal indications and speed restrictions depends entirely upon the engineer of the train.

The Safety Board has no evidence that the engineer of train 528 did not reduce speed in compliance with the "advance-approach" and "approach" signals, however, there is conclusive evidence that he did not stop at the "stop-and-proceed" signal. The frequency and severity of accidents caused by failure to obey signals varies from year to year. There are two outstanding examples of the disregard of signal indications and violation of the restricted speed rule:

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> On June 8, 1973, at Mount Vernon Station, a train which was standing at the station was struck by a following train. Fortunately, speed had been reduced before the collision and the casualties were limited to one fatality and five serious injuries.
>
> At Chicago on October 30, 1972, an Illinois Central Gulf commuter train struck the rear of a train which was backing up after overrurning the station platform. In that accident 45 persons were killed and 332 were injured. The fatalities accounted for virtually all the railroad passenger fatalities for 1972.

In both of these accidents and in the accident at Botanical Garden Station, a collision could have been avoided if the engineers of the following trains had complied with the signals.

The potential for catastrophe in each accident of this type is evident. The Metropolitan Transportation Authority found that on the lines of the New York City Transit Authority it was necessary to abandon the practice of "keying by" stop signals without authority of a second person. The practice of having the dispatcher authorize each train to resume after stopping has proven effective. After the system was implemented, and the trains equipped with radios, little train delay has resulted and there have been no rear end collisions. A system which relies on the engineer alone to comply with signals and which lacks a suitable backup system is subject to a major accident as a result of only one error.

Although a train control system requires time for installation, safeguards can be added to the current method of operation. Whereas these safeguards will decrease the probability that a following train will collide with a train ahead, the method of operation still depends on the engineer and is not as safe as a train control system. Consequently, these safeguards should be considered interim precautions only.

The Safety Board agrees with the Metropolitan Transportation Authority's recommendation No. 1 in the "Report of Special Board of Inquiry, Collision Between Penn Central Trains 526 and 528 at Botanical Garden Station on January 2, 1975," which recommends the installation of a cab signal-automatic speed control system on the Harlem and Hudson Lines.

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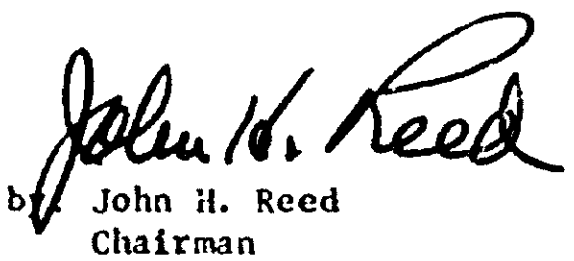
Therefore, to reduce the probability of such collisions in the future and to improve protection of the public, the National Transportation Safety Board recommends that the Metropolitan Transportation Authority:

(1) Equip all rail lines with a system that will control the speed of the train in compliance with signals when an engineer fails to do so.

(2) Until such a system can be installed, the Penn Central should be required to establish procedures to require the Metropolitan Transportation Authority train to stop at "stop-and-proceed" signals and to obtain permission from the operator or dispatcher before proceeding.

REED, Chairman, McADAMS, BURGESS, and HALEY, Members, concurred in the above recommendations. THAYER, Member, did not participate.



by: John H. Reed
Chairman

cc: Administrator, FRA

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State of New York

Metropolitan
Transportation
Authority

David L. Yunich
Chairman and
Chief Executive Officer

April 10, 1975

Notation 1473

Dear Chairman Reed:

Thank you for the copy of your Safety Recommendations R-75-6 and 7 dated March 5, 1975 concerning your Board's investigation of the collision of Penn Central train #528 with train #526 in the vicinity of the Botanical Gardens station. I sincerely appreciate your first recommendation agreeing with recommendation No. 1 of the Authority's Special Board of Inquiry that a cab signal - automatic speed control system be installed on the Harlem and Hudson Lines. Detailed engineering for this system is under way and I am actively seeking approval by the New York State Legislature and the New York State Department of Transportation to fund this project.

Recommendation No. 2, however, raises serious questions with respect to the efficacy of the solution and the operating workability of the proposed procedure. The current Penn Central operating rule states that an engineer may pass a stop and proceed signal only after first coming to a full stop. In the two Penn Central incidents cited in your report, the train engineers violated this rule and ran through signals without stopping. In the Illinois Central incident, one train was backing up and the following train was speeding through an approach signal, both in violation of operating rules. The rule proposed by the National Transportation Safety Board would not have prevented any of these incidents. The recommended procedure would create an unworkable operating practice. At the present time, an engineer must obtain permission from a tower operator or dispatcher to pass a "home signal" in an interlocking. The dispatchers or tower operators have a visual display of the conditions of the tracks and signals at these locations. However, they have no knowledge of conditions at intermediate automatic

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signals. The tower operators or dispatchers would be placed in the untenable position of advising trains to proceed past a red signal with no knowledge of conditions which exist in the block ahead.

The recommendation requiring "each Metropolitan Transportation Authority train to stop at stop and proceed signals and to obtain permission from the operator or dispatcher before proceeding" has other undesirable features. Amtrak trains and Penn Central freight trains also operate over the same tracks. All trains in Penn Central's Metropolitan Region currently operate in accordance with Penn Central's Rules for Conducting Transportation (book of rules). Train and engine crews frequently change their assignments between commuter, Amtrak and freight services. Any rule for operating MTA trains should certainly apply to these other trains as well.

The operating practices of the Transit Authority apply to a very different set of conditions. The Transit Authority's signals are spaced very closely. In fact, many blocks are less than a train in length. The Transit Authority also has frequent wayside telephones and total radio coverage.

Application of this rule to Penn Central's commuter lines would result in extensive and intolerable delays to the riding public. There are many locations particularly north of Harmon and North White Plains where radio contact is lost because of intervening hills. Likewise, in the Park Avenue Tunnel, radio contact is lost in spots despite the linear antennas. The Penn Central commuter operation covers a very extensive geographic area. There are no towers on the Hudson Line north of Harmon. The 40 miles of railroad from Harmon to Poughkeepsie are controlled by the dispatchers' office in Manhattan, some 73 miles from Poughkeepsie.

The Federal Railroad Administration conducted a Public Hearing on July 28, 1973 into the safety of Penn Central rail commuter operations in the States of New York and Connecticut. FRA conducted a thorough investigation of this matter and issued

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David L.Yunich

its report on July 26, 1974. The report notes that "approximately one third of all train accidents are caused by human factors. The FRA has completed the formulation of several proposed regulations applicable to the human-factors safety problem, and is currently conducting research and study programs preparatory to the formulation of other human-factors regulations. The first regulation of this type will probably be promulgated before the end of 1974, and will be followed by others at relatively short intervals." In this connection, FRA docket #RSOR -2 appeared in the Federal Register on March 31, 1975. Under this docket, FRA proposes to proceed with rule making concerning "stop and proceed" procedures. FRA's proposed rules would make no change in current Penn Central procedures within MTA's Region.

In conclusion, the cab signal and automatic train control system is the only real answer to the problem. Changing the rule to require an engineer to receive permission before passing a red signal does not prevent the engineer from "running" the signal. In the case of the Transit Authority, the "tripper" system forces the motorman to stop. I believe that FRA's approach to the problem through regulations applicable to human factors offers the most workable solution.

I would be happy to meet with you or your representatives to discuss this matter in more detail as you are preparing your full report of this incident.

Sincerely,

David L. Yunich

Honorable John H. Reed
Chairman
National Transportation Safety Board
Washington, D. C. 20591

cc: Honorable Asaph Hall, Federal Railroad Administration

APPENDIX D

PAST RECOMMENDATIONS TO THE FRA CONCERNING INTERIOR DESIGN OF RAIL CARS

The Safety Board has made a number of recommendations to the FRA to promulgate regulations to require that the interior design of rail passenger cars be changed to eliminate the injury-producing features found during the investigation of passenger train accidents. The first such recommendation was issued in the report of the derailment of the Penn Central passenger train at Glenn Dale, Maryland, on June 28, 1969. This recommended that the FRA:

"Initiate studies to determine the relationship between rail passenger car design and passenger injury and, where practical, take action for corrections in the design of future high-speed and rapid transit passenger cars."

This same recommendation was reiterated to the FRA in the Safety Board's report of the collision of the two Penn Central commuter trains at Darien, Connecticut, on August 20, 1969.

The Safety Board has made similar recommendations to the FRA for the correction of this problem in the reports of four subsequent railroad accident investigations which are:

1. Derailment of a Richmond, Fredericksburg, and Potomac passenger train at Franconia, Virginia, on January 27, 1970:

   "Institute immediate regulations requiring the equipment of all future, new and rebuilt, passenger cars with secured seats and luggage retention devices." In addition, the recommendation made in the Glenn Dale report was reiterated with particular emphasis to be given to the size, and methods of retention, of passenger car windows as related to this probability of window breakage and its sequel ejection and severe injury.

2. Collision of a highway truck with an Atchison, Topeka, and Santa Fe passenger train at Collinsville, Oklahoma, on April 5, 1971:

   "Review fatal passenger train accidents to determine the relationship between fatalities and window design and, to the extent practicable, promulgate regulations that will require correction of the window design and other injury-causing features in passenger cars built or rebuilt in the future."

3. Derailment of an Illinois Central Railroad passenger train near Salem, Illinois, on June 10, 1971:

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"Promulgate regulations for railroad passenger cars to minimize the sources of direct impact injury such as described in this report."

4. Collision of two Illinois Central Gulf Railroad commuter trains in Chicago, Illinois, on October 30, 1972:

"Initiate research to develop the technical approaches to crashworthiness in lightweight passenger cars for use in commuter or rail rapid transit operations."

APPENDIX E

SUMMARY OF INQUIRIES MADE OF PASSENGERS BY THE MTA

The MTA distributed questionnaires to the passengers who were riding on trains 526 and 528 on the day of the accident in an attempt to develop information on the manner in which people were injured. In addition to the 265 passengers and employees that were treated at hospitals, 148 people claimed injuries of varying degrees, many of which were treated by their physicians. A summary of this information is contained in Figure E-1.

The passengers were also requested to add any remarks that might be beneficial in preventing injuries in the future. There were 421 such suggestions offered which are divided into the following nine categories.

Item	Passengers reporting, by trains: Train 526	Train 528	Total
1. The low-back seats should be replaced with high-back seats and the handhold removed.	38	34	72
2. The high-back seats should have additional padding applied to the top and back of the headrest.	65	40	105
3. Information should have been provided over the public address system by the train crew to inform the passengers what had occurred and what to do.	56	22	78
4. The height of the high-back seats should be increased to provide adequate protection.	8	11	19
5. The windscreens should be provided with plastic unbreakable materials.	34	4	38
6. The luggage rack should be redesigned to prevent luggage from falling from the rack during similar accidents.	15	12	27
7. Side doors should be provided with a visible means for manual operation in emergency situations.	27	13	40
8. First aid kits should be provided on all trains.	18	10	28
9. Seat belts should be provided.	8	6	14
TOTAL	269	152	421

	TRAIN 526											TRAIN 520							GRAND
	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH	9TH	10TH	TOTAL	1ST	2ND	3RD	4TH	5TH	6TH	TOTAL	TOTAL
PASSENGERS REPORTING	38	50	33	24	23	34	49	59	39	37	373	30	41	43	26	33	31	204	577
MALE	30	39	29	18	19	23	30	42	29	30	289	21	30	31	19	28	27	156	445
FEMALE	8	11	4	6	4	11	8	17	10	7	84	9	11	12	7	5	4	48	132
AGE 20-30	7	8	5	6	4	10	6	10	6	7	68	4	10	9	6	7	5	47	115
30-40	8	12	7	1	2	6	4	10	6	7	43	6	8	10	6	6	8	44	87
40-50	11	12	5	4	7	8	13	12	10	9	91	6	7	10	9	8	6	45	136
50-60	8	10	10	10	6	7	11	15	10	8	95	11	6	6	3	11	9	46	141
OVER 60	2	8	6	2	4	3	3	10	4	4	46	4	3	7	1	1	2	18	64
NO AGE				1			2	2	3	2	10		1	1	1		1	4	14
RIDING FORWARD	18	26	19	13	9	10	19	26	16	15	171	14	21	26	18	19	18	112	283
HIGH BACK SEATS	12	17	15	10	7	7	12	20	13	15	128	10	18	19	15	17	12	91	219
LOW BACK SEATS	2	4	4	2	2	3	7	6	3	3	36	4	3	6		2	6	20	56
STANDING	2	4		1							7						1	1	8
RIDING BACKWARDS	20	25	14	11	14	24	19	33	23	19	202	16	20	18	11	14	13	92	294
HIGH BACK SEATS	14	19	12	11	10	20	17	28	19	14	164	12	16	14	7	12	8	70	234
LOW BACK SEATS	6	6	2		4	4	2	5	4	5	38	3	4	4	4	2	5	22	60
INJURED	28	28	25	15	11	17	26	40	28	30	243	27	37	39	20	22	24	169	413
NOT INJURED	8	22	7	9	12	17	13	19	11	7	125	3	8	4	6	11	7	39	164
NOT INJURED SEATED FORWARD	6	16	6	6	4	2	6	7	7	7	68								68
NOT INJURED SEATED REARWARD													6		4	11	5	26	26
INJURED WHEN:																			
STRUCK SEAT IN FRONT	15	13	13	9	6	8	10	23	17	13	127	16	16	24	14	14	16	100	227
STRUCK BAR OF LOW BACK SEAT	3	3	2		1		1	3	1	3	17	1	3	5		1	4	14	31
STRUCK WIND SCREEN	2			1			1			1	5	2	2	2	1	2		10	15
STRUCK BACK OF OWN SEAT		2	1	3	3	4	2	6	2	4	27	3	4	2	1			10	37
STRUCK PASSENGER		2	1	1			2			2	8	1	4	2				6	14
STRUCK WINDOW FRAME		1	1			1			1		4			1		1	3	5	9
STRUCK WALL OF CAR							1	1			2	1	1					2	4
STRUCK BY LUGGAGE FALLING					1			1		1	3								3
THROWN TO FLOOR		3					1	1			5					1	1	2	7
DID NOT HIT ANYTHING	5	3	6	1		4		8	5	3	37				1			1	38
DOES NOT KNOW	3	1							1	1	6	7	4		3			14	20
STRUCK ARM REST										2	2								2
INJURIES TO:																			
NECK	3		2			6	8	9	3	4	34	7	4	3	6	6	7	32	66
WHIPLASH	8	6	7	2	3	2	6	9	9	4	54	3	6	6	4		3	21	75
HEAD	4	6	6	7		2	4	11	3	3	46	3	8	9	4	3	2	29	75
FACE	7	5	2	3	3	2	5	6	7	8	48	6	3	11	4	8	3	34	82
LIPS	3	1			2		2	3	1	3	15	1	2	4	1		2	13	28
TEETH	1		1		1		2	2	3		10	1	3	1	4	1	3	13	23
NOSE	4	4	6		4	4	3	9	3	4	42	1	2	3	2	1	4	14	56
FRACTURED NOSE	1	2	1	1		3		3	3	3	17	2	3	7	2	3		17	34
TRUNK	1	2	2	2			3	2	1	3	16	1		2	1	1	2	7	22
LEGS	2	3	2	4		1	1	4	2	6	25	4	4	4		3	3	18	43
ARMS			1								1				1		1	2	3
HANDS							1				1	1	1					2	3
NOT WEARING GLASSES	20	20	13	10	9	20	15	36	15	19	177	15	22	23	12	13	9	93	270
WEARING GLASSES	18	29	20	13	14	14	23	22	24	18	196	15	19	20	14	20	22	111	307
MANAGED	4	8	2	2	2	4	5	5	7	8	43	8	2	7	4	6	8	35	78

Figure E-1. Summary of injuries to passengers.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

APPENDIX F

ISSUED: August 7, 1975

Forwarded to:

Mr. D. L. Yunich
Chairman
Metropolitan Transportation
Authority
1700 Broadway
New York, New York 10019

SAFETY RECOMMENDATION(S)

R-75-34 through 35

At about 8:19 a.m., on January 2, 1975, Penn Central commuter train No. 528, operating between White Plains, New York, and Grand Central Station in New York City, passed a "stop-and-proceed" signal and collided with the rear of commuter train 526 at Botanical Garden Station, New York City. Four cars of train 526 were derailed; however, damage to the cars of both trains was minimal. Two hundred and sixty-five passengers and employees were injured. Three of the injured persons were admitted to the hospital and the others were treated and released. There were 34 fractures, 75 whiplash injuries, 51 nose lacerations, and many other facial lacerations. The trains were those of the Metropolitan Transportation Authority, which were being operated by the Penn Central under contract.

Following an investigation of the accident, the National Transportation Safety Board determined that the probable cause of the collision was the failure of the engineer of train 528, while operating the train in violation of the "stop-and-proceed" indication, to perceive the train ahead in time to prevent a collision; and the lack of a backup system to control the train in accordance with the signal indication when the engineer failed to do so. The cause of the large number of injuries in this relatively moderate collision was the poor design of seats and of other interior features.

The line on which the accident occurred is provided with an automatic block signal system but is not provided with any form of train control or train stop system. When a block is occupied the signal governing the entrance to that block displays a "stop-and-proceed" aspect. After stopping short of the signal a train may proceed into the occupied block at restricted speed not exceeding 15 mph. Three signals in approach of the signal of the occupied block indicate the restricted situation.

APPENDIX F

It was disclosed during the investigation of the accident that, even though the Penn Central had requirements for annual physical examinations for engineers, the engineer of train 528 had not been so examined for a period of almost ten years. It is important to have such regulations and it is equally as important to enforce them.

This collision between trains 528 and 526 was not severe when compared to similar collisions. However, a large number of passengers sustained personal injuries. Many of these injuries were caused by deficiencies in the interior design of the cars or of the seats, which, if corrected, would eliminate such injuries in the future.

Therefore, the National Transportation Safety Board recommends that the Metropolitan Transportation Authority:

1. Require the Penn Central Transportation Company to establish procedures to assure that all train personnel operating MTA commuter trains comply with the company requirements for physical examinations. (Class I)

2. Make such alterations to the interiors of the existing M-1 commuter cars as are necessary to correct the injury-producing features of the car design discussed in this report. (Class I)

by John H. Reed
Chairman

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendation.

APPENDIX F

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: August 7, 1975

Forwarded to:

Honorable Asaph H. Hall
Acting Administrator
Federal Railroad Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

SAFETY RECOMMENDATION(S)
R-75-36 through 38

At about 8:19 a.m., on January 2, 1975, Penn Central commuter train No. 528, operating between White Plains, New York, and Grand Central Station in New York City, passed a "stop-and-proceed" signal and collided with the rear of commuter train 526 at Botanical Garden Station, New York City. Four cars of train 526 were derailed; however, damage to the cars of both trains was minimal. Two hundred and sixty-five passengers and employees were injured. Three of the injured persons were admitted to the hospital and the others were treated and released. There were 34 fractures, 75 whiplash injuries, 51 nose lacerations, and many other facial lacerations. The trains were those of the Metropolitan Transportation Authority, which were being operated by the Penn Central under contract.

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The line on which the accident occurred is provided with an automatic block signal system but is not provided with any form of train control or train stop system. When a block is occupied the signal governing the entrance to that block displays a "stop-and-proceed" aspect. After stopping short of the signal a train may proceed into the occupied block at restricted speed not exceeding 15 mph. Three signals in approach of the signal of the occupied block indicate the restricted situation.

APPENDIX F

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This collision between trains 528 and 526 was not severe when compared to similar collisions. However, a large number of passengers sustained personal injuries. Many of these injuries were caused by deficiencies in the interior design of the cars or of the seats, which, if corrected, would eliminate such injuries in the future.

Therefore, the National Transportation Safety Board recommends that the Federal Railroad Administration:

1. Promulgate regulations that will ensure that commuter trains will be controlled as required by the signal system in the event that the engineer fails to do so. (Class II)

2. Promulgate regulations to establish minimum physical standards and require periodic physical examinations of all crewmembers responsible for the movement of trains. (Class II)

3. Promulgate regulations to establish minimum standards for the interior of commuter cars so that adequate crash injury protection and emergency equipment will be provided passengers. (Class II)

by John H. Reed
Chairman

REED, Chairman, McADAMS, THAYER, BURGESS, and HALEY, Members, concurred in the above recommendation.