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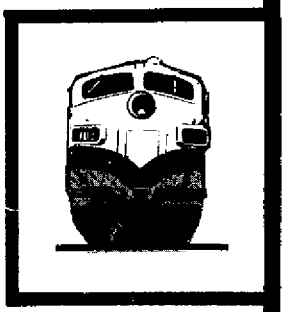
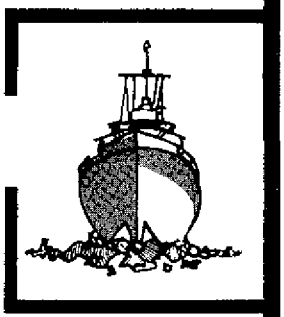
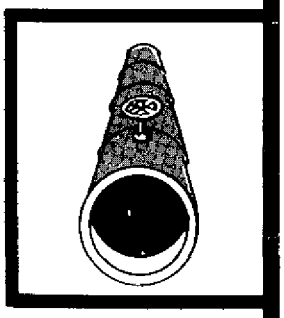
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594







RAILROAD ACCIDENT REPORT

HEAD-ON COLLISION OF NATIONAL RAILROAD PASSENGER CORPORATION (AMTRAK) PASSENGER TRAINS NOS. 151 AND 168 ASTORIA, QUEENS, NEW YORK, NEW YORK JULY 23, 1984

NTSB/RAR-85/09.

UNITED STATES GOVERNMENT

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16. Abstract

About 10:45 a.m. on July 23, 1984, National Railroad Passenger Corporation (Amtrak) trains Nos. 151 and 168 collided head-on on Amtrak's Hell Gate Line in the Astoria section of Queens, New York, New York. Train No. 151 was being operated by train order authority westbound on the No. 2 main track between Market Interlocking and the east end of Gate Interlocking. Train No. 168 was supposed to have been stopped and held at the home signal on the No. 2 track at the west end of Gate Interlocking for the arrival of train No. 151. However, train No. 168 did not stop at the home signal but continued past Gate Interlocking. The two trains collided about 1.1 miles east of Gate Interlocking. One passenger was killed; 129 passengers, 8 Amtrak operating crewmembers, and 3 Amtrak service attendants were injured. Property damage was estimated by Amtrak to have been $3,199,000.

The National Transportation Safety Board determines that the probable cause of eastbound train No. 168's continuing past Gate Interlocking, which resulted in a head-on collision with westbound train No. 151, could not be determined.

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CONTENTS

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

RAILROAD ACCIDENT REPORT

Adopted: May 14, 1985

HEAD-ON COLLISION OF NATIONAL RAILROAD PASSENGER CORPORATION (AMTRAK) PASSENGER TRAINS NOS. 151 AND 168 ASTORIA, QUEENS, NEW YORK, NEW YORK JULY 23, 1984

SYNOPSIS

About 10:45 a.m. on July 23, 1984, National Railroad Passenger Corporation (Amtrak) trains Nos. 151 and 168 collided head-on on Amtrak's Hell Gate Line in the Astoria section of Queens, New York, New York. Train No. 151 was being operated by train order authority westbound on the No. 2 main track between MARKET Interlocking and the east end of Gate Interlocking. Train No. 168 was supposed to have been stopped and held at the home signal on the No. 2 track at the west end of Gate Interlocking for the arrival of train No. 151. However, train No. 168 did not stop at the home signal but continued past Gate Interlocking. The two trains collided about 1.1 miles east of Gate Interlocking. One passenger was killed; 129 passengers, 8 Amtrak operating crewmembers, and 3 Amtrak service attendants were injured. Property damage was estimated by Amtrak to have been $3,199,000.

The National Transportation Safety Board determines that the probable cause of eastbound train No. 168's continuing past Gate Interlocking, which resulted in a head-on collision with westbound train No. 151, could not be determined.

INVESTIGATION

Events Preceding the Accident

The section A train dispatcher on the National Railroad Passenger Corporation's (Amtrak's) New York Division is located at Pennsylvania Station (Penn Station) in New York, New York. About 9:55 a.m. on July 23, 1984, the dispatcher prepared to remove the No. 1 main track on Amtrak's Hell Gate Line from service between MARKET Interlocking 1/ (MARKET) and Gate Interlocking (GATE), for the use of Maintenance-of-Way (M of W) forces. MARKET, a locally (i.e., not from a central control site) controlled interlocking facility located in the Bronx in New York City, is manned 24 hours per day. GATE, also a locally controlled interlocking facility located in the Astoria section of Queens in New York City, is remotely operated by the operator at F Tower, which too

1/ An interlocking is an arrangement of signals and signal appliances so interconnected that their movements must succeed each other in proper sequence and for which Interlocking Rules are in effect.

is a locally controlled interlocking facility and is manned 24 hours per day. Trains normally are operated westbound by wayside signal indications on the No. 1 main track and eastbound by wayside signal indications on the No. 2 main track. 2/ (See figure 1.)

At 9:55 a.m., in preparation for removing the No. 1 main track from service, the operator at MARKET reported to the train dispatcher that he had applied a PBD 3/ on the No. 1 track west at MARKET. A PBD would preclude the operator from displaying a proceed signal for westbound traffic to enter onto the No. 1 track at MARKET. At 10:01 a.m., the operator at F Tower reported to the dispatcher that he had placed a PBD on the No. 1 track east at GATE. This PBD would preclude him from displaying a proceed signal for eastbound traffic to enter onto the No. 1 track at GATE. He further advised the dispatcher that westbound Amtrak train No. 141 had passed GATE at 9:21 a.m. and that it was the last train to use the No. 1 track between MARKET and GATE.

The dispatcher then issued a format W train order, Form 19 order No. 16, addressed to an M of W Foreman at MARKET and to the operators at MARKET and F Tower taking the No. 1 track out of service between MARKET and GATE. (See appendixes C and D.) The order was made complete 4/ at 10:03 a.m.

At 10:12 a.m., the Metro North Commuter Railroad (Metro North) train dispatcher told the Amtrak section A track dispatcher that train No. 151 would pass CP Shell about 10:25 a.m. At CP Shell, train No. 151 would leave Metro North trackage and reenter Amtrak trackage. 5/ The train then would become the responsibility of the section A train dispatcher for its continued movement to Harold Interlocking (Harold) 6/ at milepost (MP) 3.7 From Harold into New York, the train director at A Tower in Penn Station is responsible for the train's movement.

At 10:24 a.m. the section A train dispatcher rang A Tower, a locally controlled interlocking facility which is located in Penn Station, on the dispatcher's telephone circuit and asked the train director if eastbound Amtrak No. 168 would leave Penn Station on time (at 10:30 a.m.) The train director said that train No. 168 would be delayed a few minutes because it was necessary to detach a baggage car from the train.

At 10:30 a.m., the section A train dispatcher rang F Tower on the dispatcher's telephone circuit and issued to the operator a format J hold order, Form 19 order No. 17 effective on the No. 2 track eastbound at GATE. (See appendixes C and D.) At 10:31 a.m., the dispatcher directed the operator at F tower to apply a PBD on the No. 2 track east. The operator responded, "PBDA on 2 west at '30." 7/ The dispatcher corrected him and said, "No, east on 2." The operator replied, "east on 2 at '32 [10:32 a.m]." The dispatcher asked the operator at F Tower what time the last eastbound train had passed GATE on the No. 2 track. The operator said, "It would be 190 at 9:41 a.m." At 10:33 a.m., the dispatcher made order No. 17 complete.

2/ Timetable direction on the New York Division of Amtrak is eastbound to Boston and westbound to New York. Timetable direction is used in this report.

3/ Panel Blocking Device (PBD)--a control applied by the operator to prevent a proceed signal from being displayed which will allow movement of a train or equipment onto the blocked track.

4/ Issuing a complete time on a train order makes it a valid operating instruction.

5/ Amtrak trains operate over Metro North between New Haven and New Rochelle (CP Shell), New York.

6/ Harold Interlocking, located 1.4 miles west of F tower, is owned and operated by the Long Island Rail Road Company, Incorporated.

7/ "PBDA" means the panel blocking device applied. The " '30" indicates 10:30 a.m.

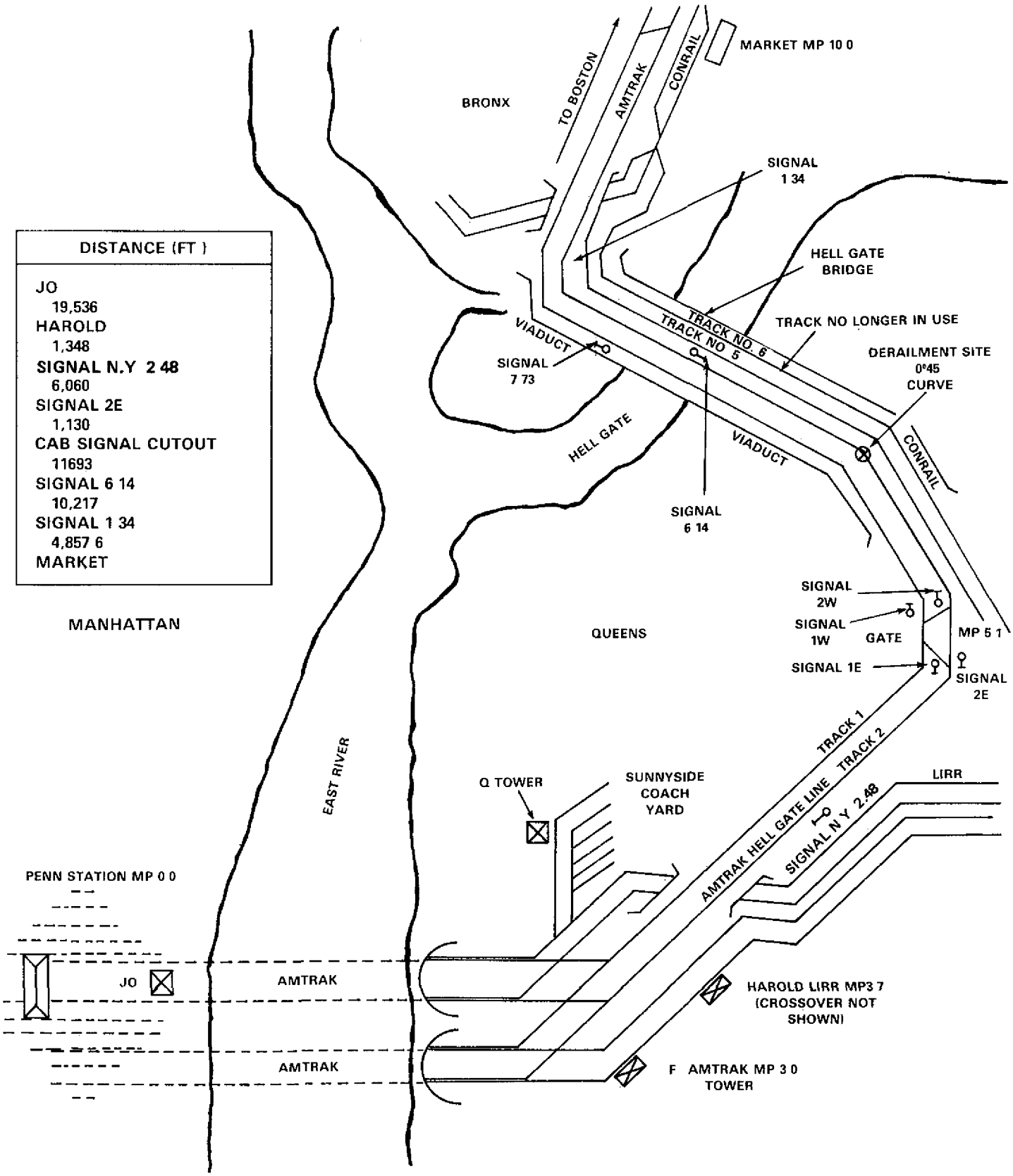


Figure 1.--Amtrak's Hell Gate Line
Penn Station to MARKET Interlocking showing the mainline only.

Following this action, the dispatcher determined that train No. 151 had passed Pelham Bay Interlocking at 10:30 a.m. At 10:34 a.m., he issued a format DR train order, Form 19 order No. 18, jointly to the operators at F Tower and MARKET, and to the conductor and engineer of train No. 151 to be delivered to train No. 151 at MARKET. (See appendixes C and D.) Order No. 18 was worded, "No. 151 engine 936 has right over opposing trains on No. 2 track MARKET to GATE." It was signed with the initials of the General Superintendent of the New York Division. After the order was repeated properly by both operators, the dispatcher made the order complete at 10:34 a.m. At that time, the operators at F Tower and MARKET confirmed a clear (unoccupied) block for train No. 151 on the No. 2 track between MARKET and GATE. The operator at MARKET proceeded to deliver the order to train No. 151, and the operator at F Tower became busy with train movements through the interlocking at F Tower proper and with copying a train order from the train director at A Tower.

The Accident

Train No. 151.--Amtrak train No. 151 is scheduled to operate daily except Sunday between Boston and New York-Penn Station. On July 23, 1984, train No. 151 departed the South Station, Boston on time at 6:35 a.m. It arrived at New Haven, Connecticut, at 9:03 a.m. where the operating crewmembers and locomotives were changed (a diesel-electric locomotive was replaced by an AEM-7, a.c. electric locomotive). Train No. 151 departed New Haven at 9:16 a.m., 5 minutes late, with locomotive No. 936 and five cars. The crew consisted of an engineer, who was alone on the locomotive, a conductor, two assistant conductors, and one service crewmember. The engineer made a running brake test after the train departed the station at New Haven, and he said the brakes operated satisfactorily.

Train No. 151 was delayed about 15 minutes en route to New York because of M of W work forces. The train stopped at MARKET because the interlocking home 8/ signal displayed a stop aspect. The operator at MARKET radioed the engineer of train No. 151 that he had a train order for him. When the engineer acknowledged this radio message, the operator changed the home signal to display a proceed aspect for train No. 151. He then left the tower and descended to the ground level to deliver the train order. Train No. 151 moved from the No. 1 track to the No. 2 track and advanced to the tower where a train order signal was properly displayed. In addition to the train order signal, the operator signalled the engineer with a green flag, which indicated to the engineer that the No. 2 main track was clear for his train between MARKET and GATE. The operator also called to the engineer that the block was clear to GATE as he delivered the train order to him. As train No. 151 moved past the operator, he delivered a copy of the train order to the conductor, who was on the first car. He noted the departure time of train No. 151 as being 10:40 a.m., and upon his return to the tower, the operator reported the departure time of train No. 151 to both the section A train dispatcher and the operator at F Tower.

Train No. 168.--Amtrak train No. 168 is scheduled to operate daily except Sunday between Washington, D.C., and Boston, Massachusetts. On July 23, 1984, train No. 168 departed Washington on time at 6:30 a.m. The train consisted of a type AEM-7, a.c. electric locomotive (No. 924), five coaches, one parlor car, and two baggage cars. Train No. 168 arrived at Penn Station at 10:19 a.m., 3 minutes late.

One baggage car was removed from the train at Penn Station. After receiving passengers, the train departed at 10:33 a.m., 3 minutes late. The crew consisted of an engineer, who was alone on the locomotive, a conductor, and two assistant conductors. Train No. 168 passed Harold at 10:40 a.m.

8/ A fixed signal governing entrance to an interlocking.

The conductor and engineer of train No. 168 did not receive copies of the hold order or the DR order which gave train No. 151 right on the No. 2 track between MARKET and GATE. Therefore, neither knew of the arrangement which would have required that train No. 168 be stopped and held at the eastbound 2E home signal at GATE. The engineer did not stop the train at GATE, but continued eastward on the No. 2 track.

The Collision.--Train No. 151 continued westward on the No. 2 main track which was not equipped with wayside signals or cab signals for trains operating in a reverse direction. As train No. 151 rounded a 0°45' right curve on the Hell Gate Line, the engineer said that he perceived the headlight of an approaching train, but that he could not determine which of three tracks it was on. (See figure 2.) The engineer of train No. 151 said that finally, as the two trains came closer together, he realized that the approaching train was on the No. 2 main track, and that he placed the train's air brakes in emergency. At the time, he saw dust coming from the locomotive of the approaching train as though the emergency brake had been applied and the emergency red strobe light illuminated. The engineer of train No. 151 left the operating compartment of his locomotive and entered the engineroom through a door located behind the engineer's position.

About 10:45 a.m., train No. 168 collided with train No. 151. Both trains were moving about 30 mph on an elevated section of track about 6,300 feet west of the 2E home signal. (See figure 2.) The locomotives and first four cars of each train derailed. The engineer of train No. 151 was knocked down in the engineroom of his locomotive, but he was able to recover and depart the locomotive through the rear operating compartment. The engineer of train No. 168 was found lying on the ground on the left side of his train adjacent to the locomotive of train No. 151.

Events After the Accident

A New York City Police Department sergeant who was on patrol duty near the collision site reported the accident to emergency forces by the 911 emergency telephone number at 10:49 a.m. Firemen from a fire station about a block from the scene responded within minutes along with Emergency Medical Services (EMS) personnel.

The F Tower operator learned of the accident when he overheard appeals for help over the railroad radio. About the same time, the section A train dispatcher overheard radio messages from a radio on the desk of an assistant chief dispatcher near the dispatcher's working area that indicated two trains had collided. The dispatcher immediately rang the operator at F Tower on the dispatcher's telephone and asked him for the location of train No. 168. The operator said, "He is by GATE." In the time that followed, the dispatcher questioned the operator at F Tower about the PBD on the No. 2 track for eastward trains, the format J hold order for No. 2 track east, and whether he had displayed a proceed signal at GATE for train No. 168. The operator at F Tower maintained steadfastly that the PBD was applied, that he was aware of the hold order, and that he did not take any action to cause a proceed signal to be displayed at GATE for train No. 168.

About 20 minutes after the accident, signal maintainers arrived at both GATE interlocking and F Tower. The maintainers checked the positions of the field equipment with the positions of the controls at F Tower. They reported that everything was in agreement between the controls and the equipment in the field as it should have been for the movement desired and described by the operator. Similarly, a relief operator who arrived at F Tower about 45 minutes after the accident to relieve the 7 a.m. to 3 p.m. operator, verified that the control indications were properly displayed for a PBD east and

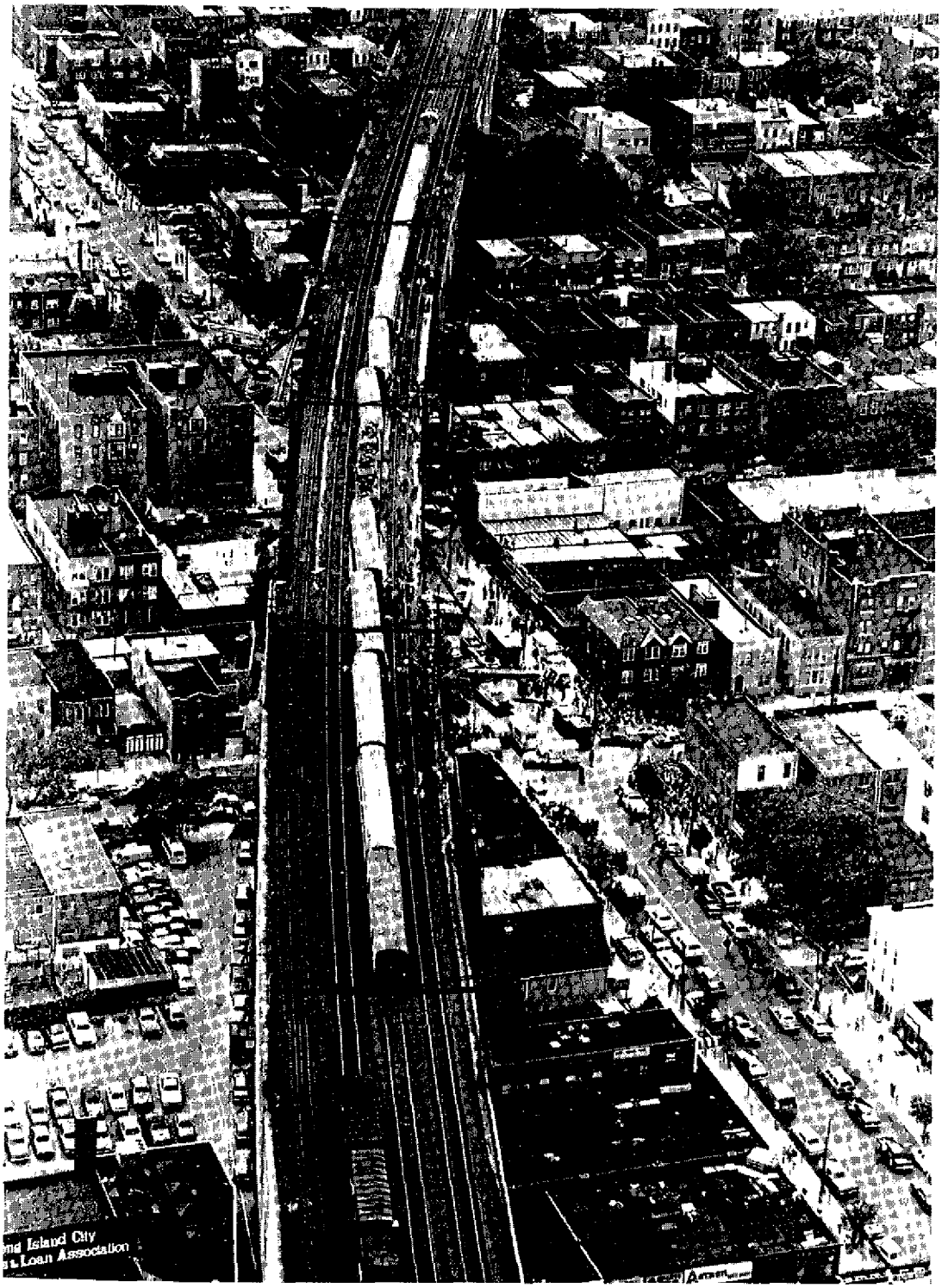


Figure 2.--Aerial view looking west of accident site.
Train No. 168 is at top of of photograph, and train No. 168 is at bottom.

west on No. 2 track and east on No. 1 track, that the blue indicating lights were illuminated for the correct PBDs, and that the signal for eastward trains was indicating stop.

Injuries to Persons

	Operating Crew	Service Personnel	Passengers	Total
Fatal	0	0	1	1
Serious	5	0	5	10
Minor/None	3	3	344	350
Total	8	3	350	361

Damage

The predominant type of damage to the locomotives and coaches of both trains was end crush damage. The operating compartment of locomotive No. 936 on train No. 151 was displaced rearward about 2 feet at the floor and about 6 inches at the roof. The floor was buckled upward. The engineer's and fireman's seats were broken loose from the floor attachments and were leaning forward onto the operating desk. All components within the operating compartment were displaced and distorted. The side door on the engineer's side was ripped loose from its hinges, and the front of the door frame was moved backward about 18 inches. The door on the fireman's side was displaced backward, but it was not unhinged. Both halves of the two-part windshield were intact and the side window frames were buckled, but the glass was not broken. (See figure 3.)

The same general crush damage was evident on locomotive No. 924 of train No. 168. However, the fireman's and engineer's seats were not broken loose from their attachments and the interior crush damage to the operating compartment was not as severe as it was to locomotive No. 936. (See figure 4.)

The vestibules of the first coach behind the locomotive of each train were crushed inward to the passenger compartment bulkhead. The side doors were either crushed or inoperative because of frame deformation. The end doors leading from the vestibules into the passenger compartments were in various positions and conditions. Some operating mechanisms were inoperable because of damage, and some operating mechanisms were operable but the doors would not function because of frame deformation which caused some doors to be jammed in either an open or closed position. Other coaches in the trains had similar damage, but the severity of the damage decreased as their location in the trains placed them farther from the locomotive. (See figure 5.)

A large number of seat locking devices, which prevent seat rotation, were broken in the first and second head cars of train No. 151 and the first, second, third, and fourth head cars of train No. 168. The majority of the two-person seats had rotated. There were reports of some windows being knocked loose from their casings because of the impact forces. (See figure 6.)

Amtrak estimated the damage to be:

Equipment	$3,189,000
Track	10,000
Total	$3,199,000

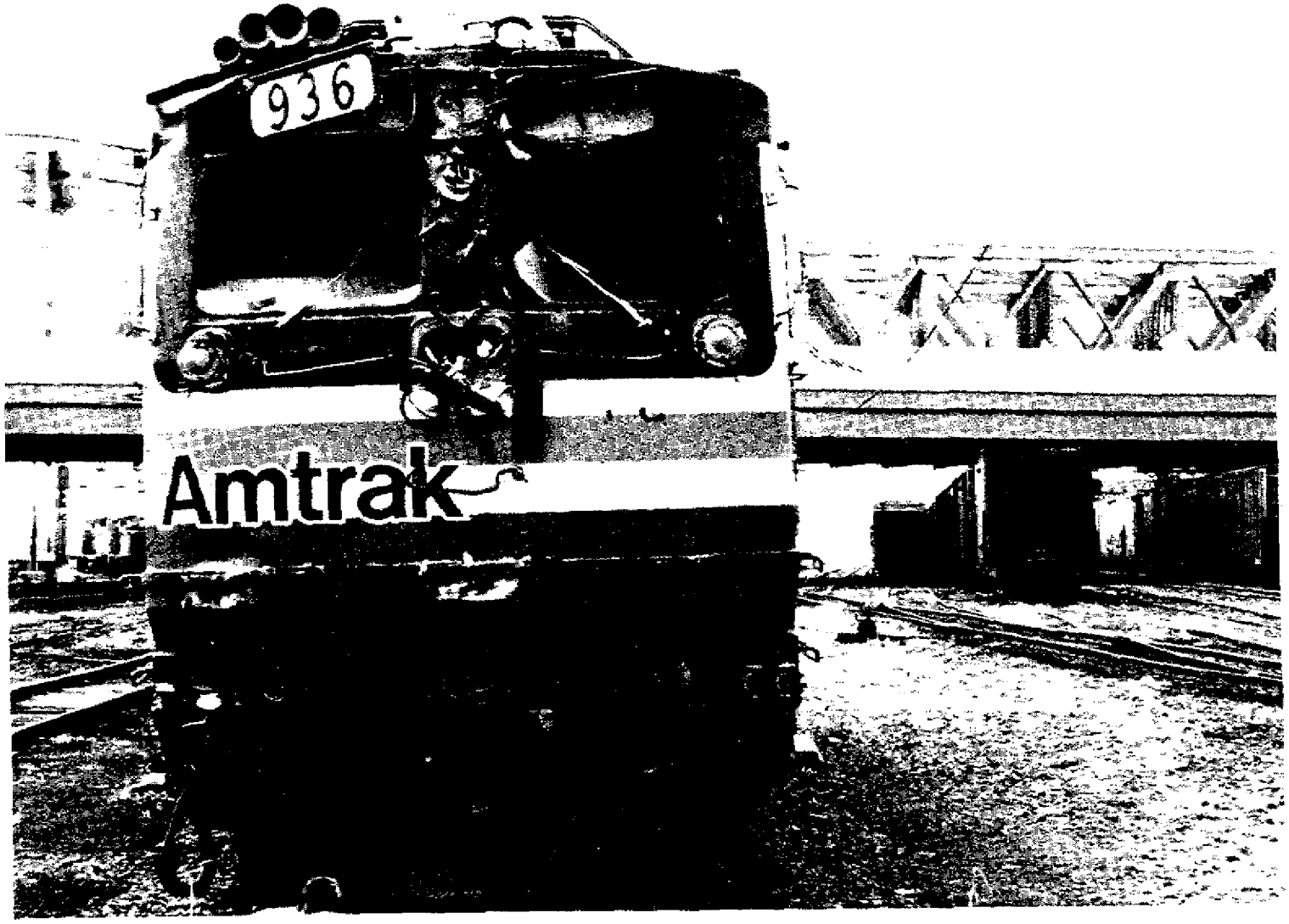


Figure 3.--Damage to locomotive No. 936 train (No. 151).

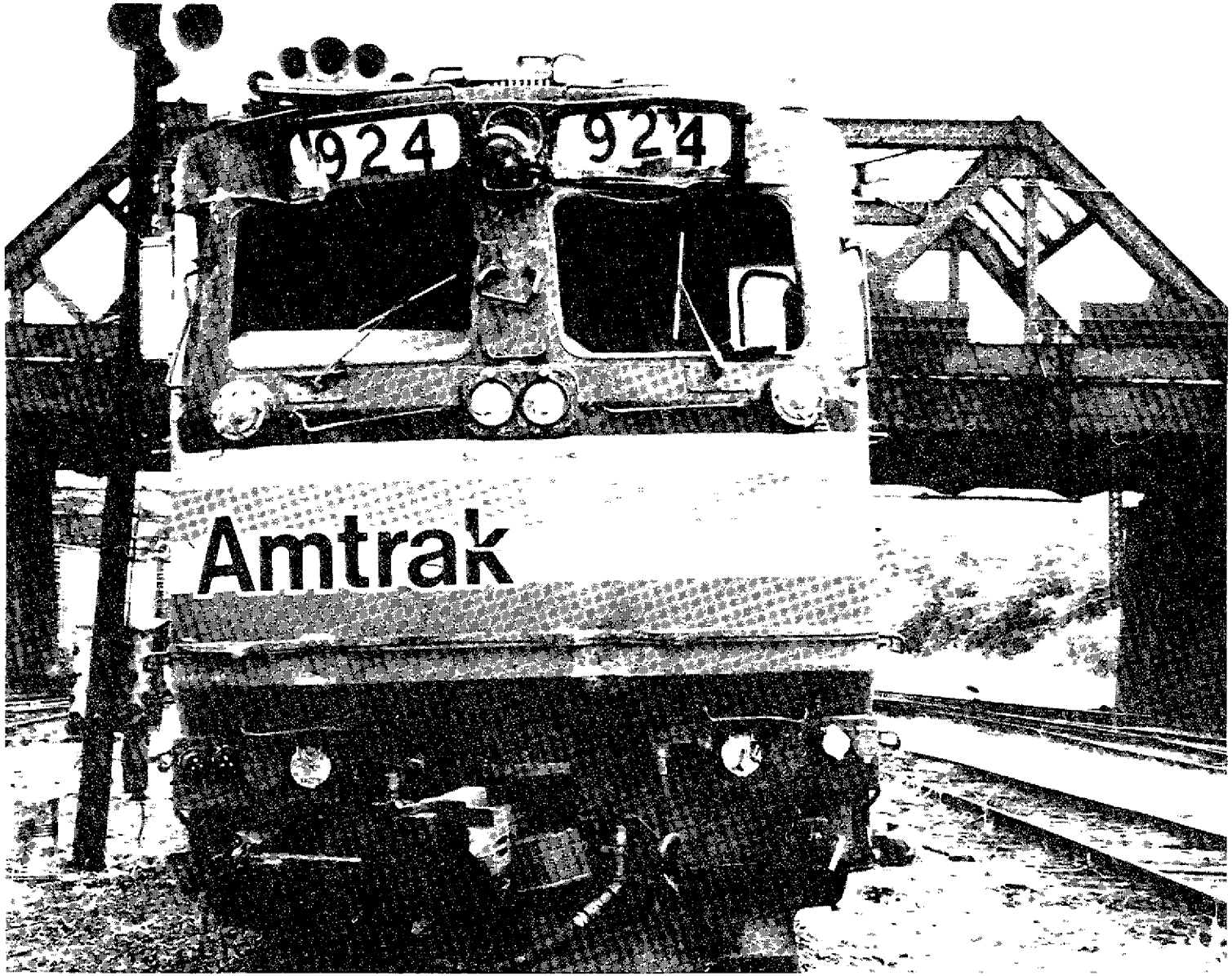


Figure 4.--Damage to locomotive No. 924 train (No. 168).

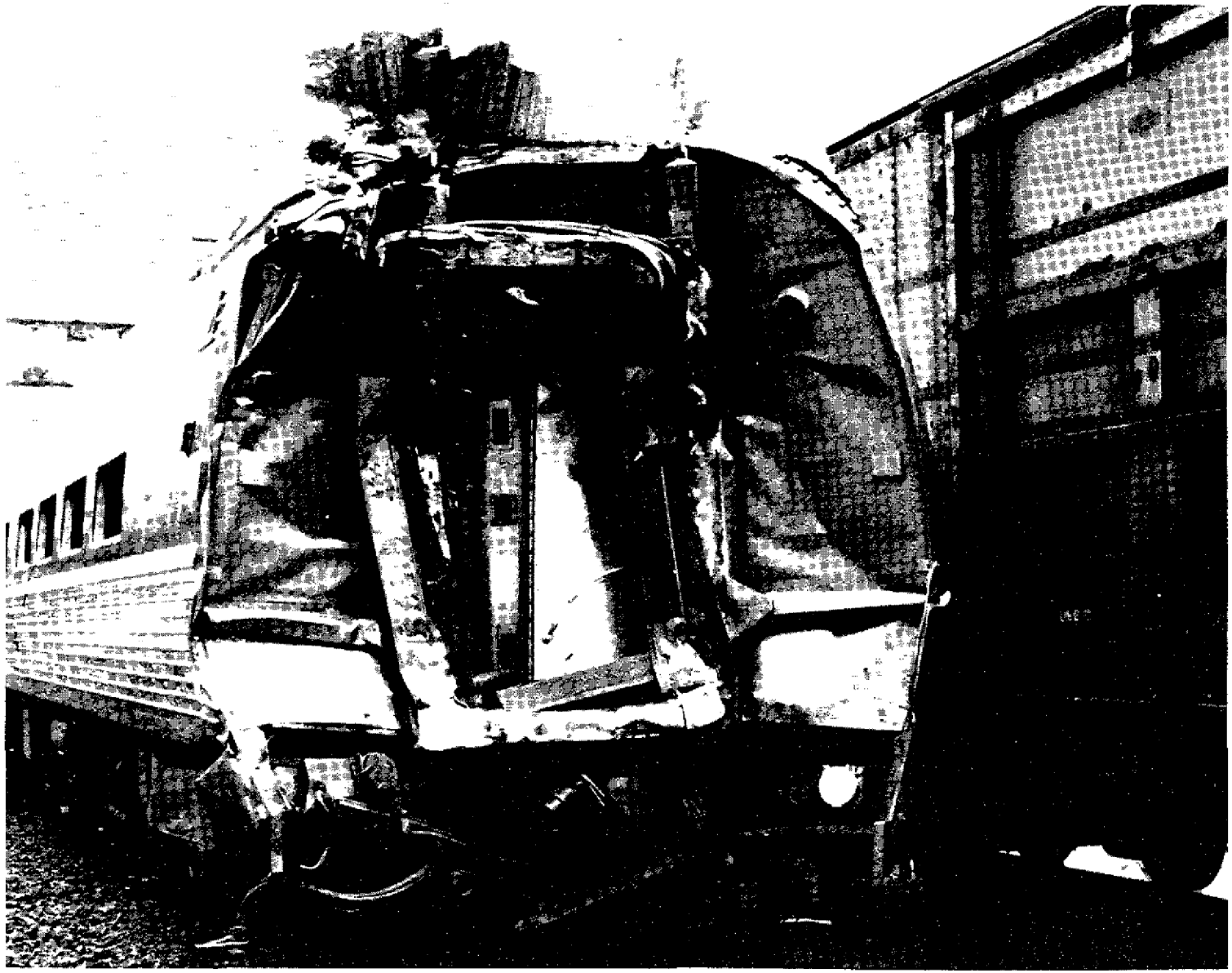


Figure 5.--Damage to coaches typical for each train.

Figure 6.--Interior view of typical coach disarrayment and condition.

Personnel Information

Train Dispatcher.--The train dispatcher was hired as a block operator 9/ by the Pennsylvania Railroad on July 26, 1967. He qualified as a train dispatcher on the Penn Central Railroad in 1974. Since his association with Amtrak, he has received further training as a dispatcher at Amtrak's dispatcher training school. He was qualified properly on Amtrak's operating rules as a train dispatcher and as a block operator according to company requirements. On February 6, 1984, he received a grade of 100 percent on his most recent operating rules examination. A minimium passing grade is 85 percent, and operating rules examinations are required annually.

The train dispatcher was assigned regularly as assistant chief dispatcher on a relief position 10/ which required him to work rotating shifts. Before being employed by Amtrak, he had been a qualified block operator on the Pennsylvania Railroad, the Penn Central, and the Consolidated Rail Corporation (Conrail). In addition to his regular position, he is an extra train dispatcher and works as a relief train dispatcher when temporary vacancies occur in the dispatcher's officer.

On July 23, 1984, the train dispatcher was working a temporary vacation relief vacancy as the section A train dispatcher from 7 a.m. to 3 p.m. The dispatcher said that he was well rested and that he had no personal concerns that would have affected his performance on the job.

F Tower Operator.--The F Tower operator was employed as a block operator by the Penn Central Railroad on May 20, 1973. His employment as a block operator continued with Amtrak when it took over portions of Conrail in 1976. He was qualified on Amtrak's operating rules according to company requirements. On February 1, 1984, he made a grade of 100 percent on his most recent operating rules examination. He was qualified to work about 10 interlocking towers on the New York Division in and around the New York/New Jersey area.

The preponderance of the F Tower operator's assignments had been as a leverman working under the direct supervision of an operator or a train director. Co-workers said that he reported trains to them promptly and that they had no special concerns about his properly reporting trains to them when they worked with him.

On June 21, 1984, the Division Operator issued Amtrak bulletin No. 84-21 advertising a vacancy at F Tower with duty hours of 7 a.m. to 3 p.m. The F Tower operator, at that time employed as a leverman at JO Tower in Penn Station, placed a bid for the vacancy, and on June 28, Amtrak bulletin No. 84-22 awarded him the position, based on his qualifications and seniority.

In 1977, the F Tower operator had qualified to work at F Tower where he worked the 11 p.m. to 7 a.m. shift one day a week on a regular relief assignment for about 6 months. Subsequently, he worked at F Tower one time, about 6 months before he was awarded the

9/ Block operator, tower operator, interlocking operator and, sometimes, telegraph operator are used synonymously to describe a person who operates switches, signals, and copies train orders and does work necessary to advance trains along the route or in terminals.

10/ The 5-day work week leaves 2 days on a 7-day per week job to be filled by another employee. These 2 days are combined with similar days from other offices or shifts to form a 5-day relief job.

first shift as a regular assignment. The operator did not work at F Tower again until after GATE Interlocking was placed in service on June 28, 1984, as a remotely controlled interlocking before he was awarded the regular assignment at F Tower. The operator reported for duty and first worked his new assignment shift at F Tower on July 2, 1984.

About 7:30 a.m. on July 2, an Amtrak special duty rules examiner, who was qualified on the operation of a newly installed control panel for GATE, arrived at F Tower to instruct the operator on the use of the control unit. The instructor remained at F Tower until 3 p.m., the end of the operator's tour of duty. Before the instructor departed F Tower on July 2, he asked the operator if he understood the operation of the control unit for GATE or if he wanted additional instruction. The operator told him that he understood how to operate the control unit to obtain the various control functions and indications, and that he did not believe he had any further need of the instructor's services.

About 10 p.m. on July 2, the operator requested for personal reasons to be temporarily relieved of duty at F Tower commencing at 7 a.m. on July 3. The request was honored, and the operator did not return to F tower until 7 a.m. on July 10. When he reported for duty, the F Tower operator asked the assignment clerk if anyone was available that day to be with him for additional instruction on the GATE control panel. He was told that the special duty rules examiner who had instructed him on July 2 could be there. However, because the special duty rules examiner had a commitment unknown to the assignment clerk, he did not go to F Tower on July 10, and the operator remained on duty without additional help.

The operator testified that when the vacancy at F Tower was advertised, the remotely controlled GATE installation was not in service. However, later he admitted that he knew the GATE installation was in progress when he bid on the vacancy. Nevertheless, he believed that the job had been misrepresented because of the addition of the responsibility for the control of GATE to the position at F Tower after the vacancy had been advertised and as a result he was reluctant to remain on the assignment. In addition, he had talked with several operators who had worked at F Tower after the GATE installation was placed in service and apparently they convinced him that the new responsibility was laden with operating problems and inconsistencies which created an unsafe condition. Based on this information from the operators about the GATE installation and on his own belief that the addition of this responsibility to the job was unfair, the F Tower operator made several attempts through his line of supervisors to be relieved of the assignment. His supervisors did not believe that the reasons he gave in seeking a release from the assignment were valid and, therefore, he was advised that he was expected to work the assignment.

The F Tower operator told Safety Board investigators that he understood the operation of the GATE control panel. At the public hearing on the July 23 accident, testimony from the F tower operator demonstrated that he had a good working knowledge of the operation of the GATE control panel. The F Tower operator said that normally he did not use the fleet mode 11/ for signals at GATE on his tour of duty. However, the F Tower signal maintainer gave a statement to Amtrak supervisors that on numerous occasions when he entered the tower on the 7 a.m. to 3 p.m. shift, the signals at GATE

11/ A selectable mode whereby a controlled signal, which normally has to be changed to proceed each time a train is allowed to pass it, will function as an automatic signal and negate the necessity of an operator having to change it to proceed each time it is to be used to allow the passage of a train.

were in the fleet mode. When Safety Board investigators questioned him in an initial interview on July 25 after the accident, the F Tower operator did not have a clear understanding of the manual block operating rules. The F Tower operator later said that he was comfortable with the work routine associated with F Tower proper except for the GATE control panel.

Besides the belief that the job had been misrepresented to him, the operator expressed concern and confusion about jurisdictional limits under manual block operating rules among the operators at F Tower, Harold, and MARKET. He said that because Harold Tower was between F Tower and GATE and GATE was between MARKET Tower and Harold, he was confused about which operator controlled the tracks between these points.

A July 9, 1984, memorandum issued by the Division Operator and addressed to a distribution list which included the operators at F Tower, attempted to clarify any confusion that existed as to the operators involved in various moves in that area. The F Tower operator said that he never saw the memo and Safety Board investigators did not find the memo posted at F Tower.

MARKET Operator.--The operator at MARKET was originally hired by the New York, New Haven and Hartford Railroad (NYNH&H) as a block operator. He became an employee of Amtrak in 1976. He was qualified on the Amtrak operating rules in accordance with company requirements. On April 6, 1984, he passed the annual operating rules examination satisfactorily. He had worked at MARKET on two separate assignments for a total of more than 19 years. He said that he was well rested on July 23 and that he was not taking any medication that would have affected his performance on the job.

Engineer, Train No. 151.--The engineer of train No. 151 was hired by the NYNH&H railroad on August 16, 1957, as a locomotive fireman. He was promoted to engineer on November 16, 1969, and he has held supervisory positions as a Road Foreman of Engines for Amtrak and its predecessor, the Penn Central. He was qualified for his position on the Amtrak operating rules in accordance with company requirements. On May 19, 1984, he received a grade of 92 percent on his most recent operating rules examination. He worked a regular assignment 5 days a week which consisted of a round trip between New Haven and New York. On July 23, the engineer of train No. 151 reported for duty at 8:33 a.m. at the motor pit at New Haven where he obtained the locomotive for the trip to New York with train No. 151. He was scheduled to return from New York to New Haven on train No. 174. He said that he had rested well the evening before the trip, that he was not taking any medication, and that he was not concerned about any personal problems.

Engineer, Train No. 168.--The engineer of train No. 168 was employed by the NYNH&H railroad on September 4, 1952, as a locomotive fireman. He was promoted to engineer on January 29, 1965. He was qualified on the company operating rules for his position in accordance with company requirements. On May 10, 1984, he received a passing grade of 96 percent on his most recent operating rules examination.

The engineer of train No. 168 held a regular 5 days per week assignment operating train No. 291 from New Haven to New York and train No. 168 from New York to New Haven. On July 23, following his regular schedule job assignment, the engineer on train No. 168 was assigned to operate train No. 291, scheduled to depart at 6:35 a.m., from New Haven to New York. Train No. 291 departed New Haven about on time, but it arrived at New York at 8:55 a.m., 6 minutes late.

The engineer "layed over" at Penn Station until the departure of train No. 168 at 10:33 a.m. During the 95-minute layover, he talked to and was observed by mechanical department personnel who knew him and who said that he appeared to be in good spirits and that he was alert. Supervisors and coworkers said that they considered the engineer to be a reliable and efficient engineer.

Amtrak supervisors were able to interview the engineer briefly at the hospital on the afternoon of the accident. The engineer could not recall the signal aspect of the distant 12/ signal to the GATE Interlocking or the aspect of the 2E home signal at GATE. The engineer believed that at Harold an approach medium aspect was displayed on the distant signal and a medium clear aspect was displayed on the home signal. However, he based this belief on the speed at which he remembered he was operating his train and the running time between JO Tower and Harold. Those aspects normally would be presented to eastbound trains through the Harold Interlocking when there were no trains or obstructions immediately ahead. Also, he believed that clear signal aspects were displayed for his train as he approached GATE, both on the distant signal, NY No. 2.48, and on the GATE home signal, because he believed he would not have maintained the train's speed at 40 mph in that area if the signals had displayed a more restrictive indication. He said that he did not remember acknowledging a change in the locomotive cab signal to a more restrictive indication as would have been necessary had the train's speed been greater than that allowed by the wayside signal aspects.

The engineer of train No. 168 said he remembered seeing the headlight of a train approaching him east of GATE, and he said that he could not believe what he saw--the approaching train was on the same track as his train. He recalled putting his train brake in full suppression, getting out of his seat, and moving behind it where he watched the oncoming train. He believed that he opened the outside door behind the engineer's seat but that he was not certain he did so.

The engineer of train No. 168 was not interviewed by Safety Board investigators because he has retrograde amnesia 13/ as a result of head injuries received during the accident. A number of attempts were made by the Safety Board investigators and Amtrak representatives to interview the engineer, but his physician maintained that the engineer had no recall of events leading to the accident and immediately after the accident. His physician provided the Safety Board with a letter describing and certifying his condition.

Locomotive and Train Information

Locomotives Nos. 924 and 936.--Amtrak locomotives Nos. 924 and 936 were model AEM-7 a.c. electric locomotives manufactured by the Electromotive Division (EMD) of General Motors Corporation. Propulsion power is obtained from an 11KV 25hz catenary system via a Faiveley DS-11 two-stage pantograph at either end of the locomotive. The maximum speed of the locomotive is 125 mph. Each unit weighs 201,750 pounds and is 51 feet 2 inches long and 10 feet 6 inches wide. Battery power is provided by a 64-volt nickel cadmium battery complement rated at 170 ampere hours for an 8-hour period.

12/ A fixed signal used to govern the approach to an interlocking signal. A fixed signal is defined as: a signal of fixed location including such signals as switch target, train order, block, interlocking, speed signs, stop signs, or other means of indicating a condition affecting the movement of a train or engine.

13/ Amnesia for events which occurred before the trauma or disease causing the condition. Dorland's Illustrated Medical Dictionary, 23rd Edition.

Braking is achieved by the blending of air and dynamic brakes through a 26-LIC/CS-1 brake valve. The locomotive windshields are glazed with a 9/16-inch acrylic pane which will withstand a projectile, such as a ballast stone, at 120 mph.

Locomotive No. 924 was equipped with a Pulse Electronics, Inc., cassette event recorder. It monitored and recorded speed, brake action by the independent locomotive brake, the automatic brake and the dynamic brake, the electrical load (amperage), and the locomotive horn operation. Locomotive No. 936 was equipped with a Barco speed recorder which recorded speed only. Both locomotives were equipped with multi-channel radios, cab signals and train control, an alerting device, sanders which automatically apply sand when the brakes are applied in emergency, strobe lights that automatically illuminate when the bell is actuated, and an emergency red light that illuminates when the emergency brakes are applied or if the brakepipe pressure drops below approximately 60 psi.

The locomotives are equipped with a cab signal cutout switch which, when operated, disconnects the cab signal rail pickup coils from the circuit, and simultaneously pre-sets the maximum authorized speed for the locomotive at 79 mph. The three-position rotatable cab signal cutout switch is located on the engineer's operating desk. It can be positioned for: (1) terminal operation, which limits the locomotive's speed to 20 mph, (2) cab signals cut-in and effective with speed control, and (3) cab signals cutout. The cab signal indication will display a restricting aspect when the cutout switch is in the cutout position. When the switch is in the cut-in position, the switch is secured with a lead sealed wire to a post adjacent to the switch. The switch must be sealed when the locomotive departs its initial terminal. The seal indicates that the cab signals and train control have been tested and that they are operating properly.

The AEM-7 locomotive is designed for a buff load of 600,000 pounds. The locomotives were designed based on their use in metroliner service and the projected service load of six Amfleet coaches. One of the locomotives (No. 936) buckled just forward of the rear part of the operating compartment. It appeared that the other locomotive (No. 924) climbed up over the coupler and struck the front part of the anti-climber on locomotive No. 936, which is not unexpected in a head-on collision. Cabinet doors in the engine-room opened and some of the engineroom components appear to have shifted somewhat from the collision forces.

Passenger Coaches.--The Amtrak (Amfleet) passenger coaches were built by the Budd Company between 1974 and 1977. The coaches are constructed of stainless steel with the exception of the end underframe. The overall length of a car is 85 feet 4 inches. The maximum height above the top of the rail is 14 feet 8 inches, and the maximum width is 10 feet 6 inches. Power operated sliding side doors give access to the car vestibule from the station platform and sliding doors (also power operated) are located at each end for access to the passenger compartment from the vestibule. The side and end doors can be operated manually if electric power is lost. Power for emergency lighting facilities is provided by onboard storage batteries.

The Amfleet coaches were designed to withstand a buff load of 800,000 pounds, which represents a collision load of about 6 to 8 G's depending on the passenger loading and weight of the coach, and to absorb major impact damage by collapse of the structure near the ends of the cars. Other design strengths used by Amtrak that are equal to or exceed Federal Railroad Administration (FRA) requirements or Association of American Railroads (AAR) standards are:

To insure support for collision posts	15,000 pounds
Resist end penetration *	300,000 pounds per post within 15° of longitudinal center line
Anti-telescoping	300,000 pounds per post (ultimate)
Anti-climbing	100,000 pounds
Buffer gear collision resistance	500,000 pounds

*Note: This 300,000-pound load is to be applied 18 inches above the floor as a result of acceptance of a Safety Board recommendation.

The seat tracks were designed for a 5 G longitudinal force, which is more than the force which will pitch an unrestrained passenger from a seat. None of the seat tracks came loose even on the first two cars behind the locomotive where the greatest forces occurred. There was movement of the seats due to rotation, however.

Major crash damage occurred to the cars in the area of the vestibules. The same type of damage also was evident on both ends of both AEM-7 locomotives.

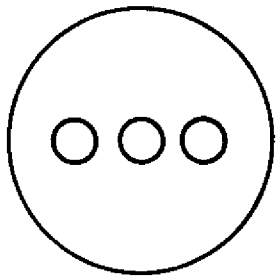
Method of Operation

Amtrak's New York Division, which is part of the Northeast Corridor from Washington to Boston, extends from Trenton, New Jersey, milepost 57, to New Rochelle, New York, milepost 18.9. Trains are operated over the New York Division by the aspects of position light and/or color position light automatic wayside signals (see figure 7) and interlocking block stations manned by block operators.

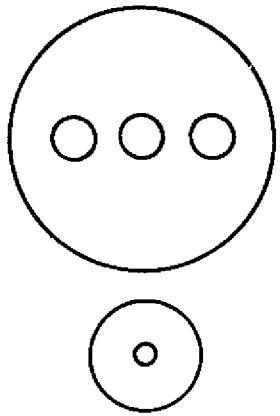
The section A train dispatcher controls train movements between New Rochelle (CP Shell) and Harold. Control of Amtrak trains between Harold and Penn Station is vested in the train director at A Tower. The section A train dispatcher also has control of train movements between A Tower and Union Tower Interlocking (Union) at Rahway, New Jersey. The section B train dispatcher controls trains movements between Union and Fair Tower Interlocking at Trenton.

Train operations between CP Shell and Harold are governed by operating rule No. 251. Rule No. 251 establishes the current of traffic (direction of movement) westbound on the No. 1 track and eastbound on the No. 2 track. Train movements are governed by the aspects of an automatic block signal system (rules Nos. 501 to 512). When trains are operated against the established current of traffic, manual block rules Nos. 301 to 342 apply. Rule No. 261 permits train operation on the same track in either direction by the aspects of automatic block signals. Train orders are not necessary. Trains are operated between IO Tower and Harold by rule 261 or a modified version of it. (See appendix B.)

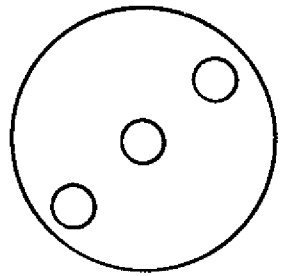
In rule 251 territory, in order to operate a train against the current of traffic, the dispatcher must issue a format J hold train order (see appendix B) to the block operator who controls the movement of trains onto the track in the direction of the established current of traffic. Before the hold order can be made complete, the operator must apply a blocking device to block the track affected. The operator then must provide the train dispatcher the time the blocking device is applied. The dispatcher, in turn, records the time and makes the train order complete. Except for the operator's confirmation, the dispatcher cannot check or verify that a PBD or BD is applied properly.



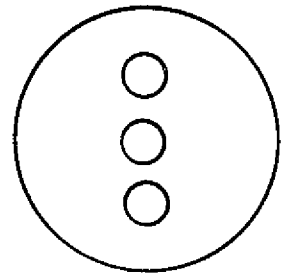
WAYSIDE SIGNAL
NAME: STOP SIGNAL
INDICATION: STOP
RULE: 292



WAYSIDE SIGNAL
NAME: STOP AND PROCEED
INDICATION: STOP, THEN PROCEED AT RESTRICTED SPEED
RULE: 291

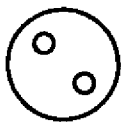


WAYSIDE SIGNAL
NAME: APPROACH
INDICATION: PROCEED PREPARED TO STOP AT NEXT SIGNAL. TRAIN EXCEEDING MEDIUM SPEED MUST AT ONCE REDUCE TO THAT SPEED.
RULE: 285



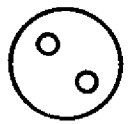
WAYSIDE SIGNAL
NAME: CLEAR
INDICATION: PROCEED
RULE: 281

CAB SIGNAL
DISPLAY



NOTE: FIXED SIGNAL INDICATION WILL GOVERN

CAB SIGNAL
DISPLAY



NOTE: FIXED SIGNAL INDICATION WILL GOVERN

CAB SIGNAL
DISPLAY

CAB SIGNAL
DISPLAY

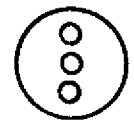


Figure 7.—Position light signal aspects.

Next, the dispatcher issues a format DR train order (see appendix B) copied by the block operators but jointly addressed to the train affected, the operator at the entrance to the signal block where the reverse running will begin, and the operator controlling the entrance/exit at the end of the reverse running block. When both operators repeat the train order correctly, it is made complete and it then is delivered to the train for fulfillment.

The running of trains against the current of traffic between MARKET and GATE with GATE remotely controlled was a new procedure. Before GATE was placed in service, a move of this nature would have been from MARKET to Harold. The engineer of train No. 151 said this was the first time he had made this particular move of crossing from the No. 2 track back to the No. 1 track at GATE. Previously, (since 1980) when trains had to be crossed over from one track to the other at GATE, a temporary block station had been established with an operator at GATE to handle the trains and switches.

On June 28, train No. 173 was operated on the No. 2 track between MARKET and GATE. On July 2, a day the F Tower operator had worked, trains Nos. 151, 169, and 95 were operated on the No. 2 track between MARKET and GATE. Between July 3 and 9, when the F Tower operator was on personal leave, a number of movements against the current of traffic were made between MARKET and Harold.

On July 10, the first day the F Tower operator returned to work, train No. 66 was operated eastward on the No. 1 track between Harold and GATE and train No. 67 was operated westward on the No. 2 track between MARKET and GATE. Between July 10 and July 20, 19 eastward or westward movements were made against the current of traffic between Harold and MARKET. Three additional moves during the same period involved a train's train order rights ending at GATE.

When a track is to be given to M of W forces or others for their use, the train dispatcher has the option of determining the convenient time to take a track out of service. The regularly assigned dispatcher usually waited until trains Nos. 151 and 168 were through the area before he took a track out of service.

On July 23, Amtrak did not have an operating rule that required the engineer of a train which had its rights restricted by a DR order to be informed of the reason for the restriction or that the train's rights had been restricted. There was no requirement that train No. 168 be given advance advice about the move that was being made. Operating rule No. 204 reads in part ". . .train orders must be addressed to those who are to execute them," which would not have included train No. 168. Engineers of all trains are supposed to operate their trains in accordance with the signal aspects displayed for them. (See appendix C.)

Before an operator can admit the train holding a format DR train order into a block against the current of traffic, he must obtain a clear block verification from the operator controlling the entrance to the opposite end of the block. He must record the time on his record of train movements and convey the clear block information to the engineer of the train with the format DR train order by a hand signal with either a green flag or green light. Under certain circumstances, a radio message may be given (rule 334). (See appendix C.) The delivery of the train order to the train must be accompanied by a clearance permit Form C 14/ under certain circumstances and, in all instances, a clearance card Form A 15/ (rules 331, 211, and 221) except when a train order

14/ A permit authorizing an engineer to operate his train past a stop signal.
15/ A form authorizing an engineer to pass a train order signal and specifying the train orders, if any, he should have received.

is transmitted or relayed to the engineer or conductor via radio or telephone. (See appendixes B and C.)

Amtrak shares radio channel one in the New York City area with Conrail and radio channel two north of CP Shell with Metro north. Both channels are assigned to Conrail. Channel one is heavily used because the New Jersey Transit Rail Operations, Inc. uses it when it has trains operating on Amtrak trackage and it is used around Sunnyside Yard. On the day of the accident, there was difficulty detecting the emergency calls from the wrecked trains because of the density of traffic on radio channel one.

Amtrak had made an attempt to obtain an assigned channel for its use in the Northeast Corridor by working with the AAR. However, because realignment of some channels between other rail carriers could not be accomplished, the project was never completed.

Gate Interlocking

The operator at F Tower cannot see the interlocking facilities at GATE which he remotely controls and operates. GATE Interlocking consists of two crossovers between tracks Nos. 1 and 2 and four signals. The remote control panel is equipped with four signal control buttons, four control buttons for panel blocking devices, two switch control levers, some propulsion control levers for future application, several other nonvital control functions, and various indication lights. (See figure 8.)

The control buttons are six-way controls. A white dot indicates the button's position. The controls can be operated push-pull with the white marker up, or with the white marker rotated either 90° to the left or the right.

A stop signal aspect is changed to proceed by pushing the appropriate control button. A fleet mode is established (for signals only) by rotating the control button for the proceed signal so that the white marker points in the direction of the train movement and then pushing the control button a second time. The fleet mode is cancelled by pulling the signal control button and rotating it so the white marker is up. Cancelling the fleet mode does not place the signal at stop. The proceed signal is cancelled by pulling the control button a second time when the white marker is up. When the signal is cancelled, the aspect in the field changes to stop immediately, but because straight time locking 16/ is used at GATE, the operator is required to wait about 3 minutes from the time the signal is cancelled until a route through the interlocking can be changed. F Tower operators are not provided with an annunciator bell to signal a train's approach to GATE.

Panel Blocking Device.--When a PBD at GATE is activated, the operator cannot operate any signal to cause it to indicate a proceed aspect over a route that would lead onto the blocked track. The activated PBD does not block switches, only signals. The activated PBD opens the signal control circuit for any route onto the blocked track so a proceed signal cannot be displayed.

16/ When a proceed signal aspect is cancelled, a time delay is imposed before a change in a route can be made whether a train is on the approach circuit or not. Approach locking differs in that a signal can be placed at stop and routes through an interlocking changed at anytime without the time delay being imposed unless a train is on the approach circuit to an interlocking.

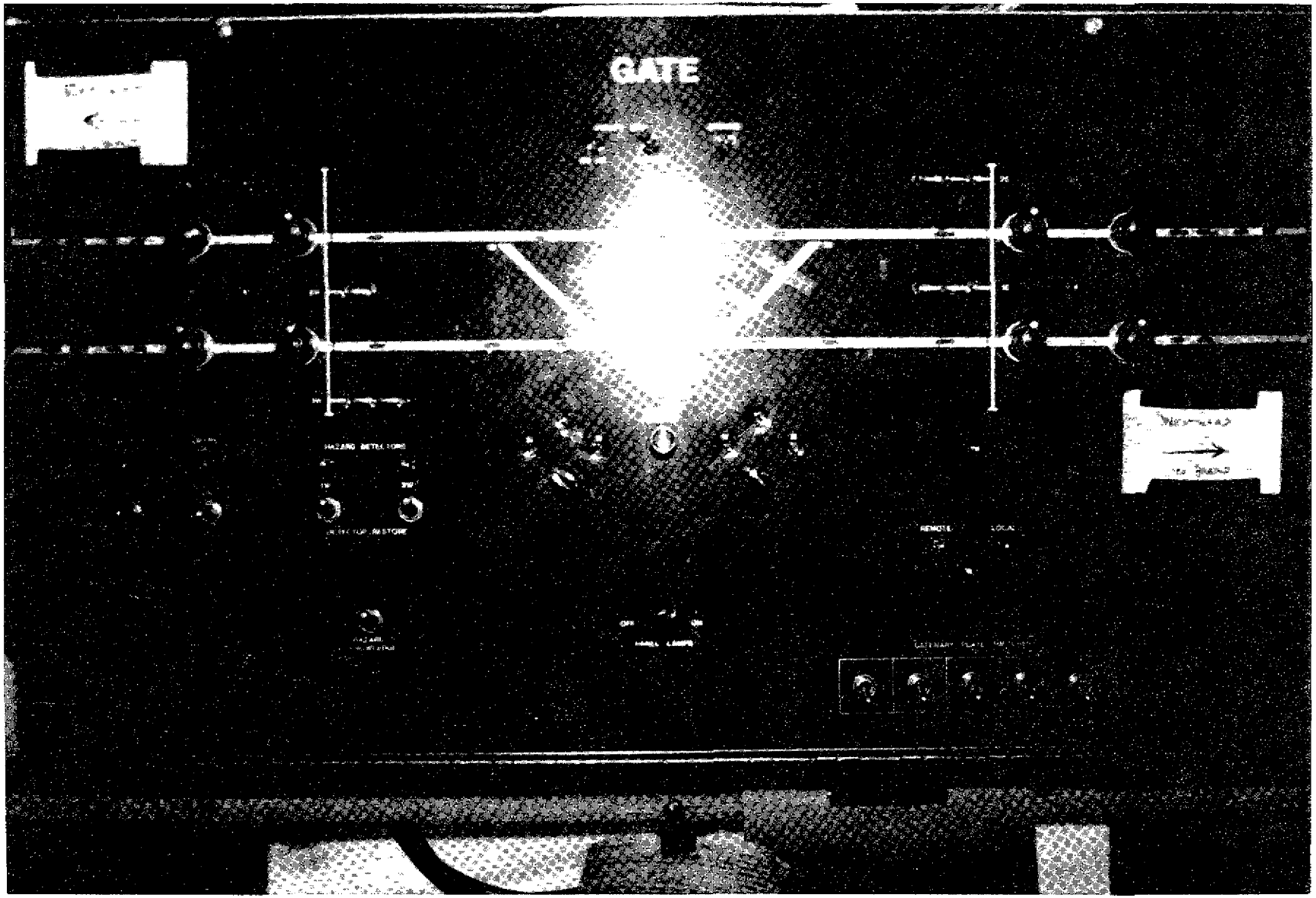


Figure 8.--Gate control panel. (Hand written labels not applied by the Safety Board.)

The operator is required to record the time the PBD is applied on his record of trains block sheet in red ink and to report the time to the dispatcher. The dispatcher similarly is required to record in his train order book in red ink the time the PBD is applied. Only the dispatcher can order that a PBD be applied and/or removed.

To apply a PBD, the governing signal must be at stop. The control button for the PBD is rotated so that the white marker is toward the traffic that is to be blocked, and then the control button is pushed. A blue indicator light illuminates when blocking is effective. To remove the PBD, the PBD control button is pulled and then rotated so that the white marker is up.

A switch can be operated anytime if the signals governing movements over the switch are at stop and have timed off, and the track is not occupied. To reverse a switch, the switch control lever is rotated about 45° clockwise and a code button pushed to initiate a code. 17/ To position a switch in its normal position, the steps are taken in reverse action. When a function code is sent to the field, an indication of the requested function is sent automatically back to the control panel to indicate that the requested function was or was not accomplished.

The control panel for GATE can display the following information:

Facility	Status	Indication Displayed
Switch	Normal	Green light
	Reverse-locked	Yellow light Red light
Signal	Stop	Red light
	Stop and Proceed	Flashing red light
	Proceed	Green light
	Fleet mode	White light plus green light
	Timing out	No lights on signal indication lights
	Request for Signal	Green light in center of control button
Panel Blocking Device	Not applied	No light on indicator
	Applied	Blue light
Track occupancy	Not occupied	No light on track
	Occupied	Yellow light illuminated on track segment occupied

17/ To reverse a switch, a prearranged code sequence consisting of a series of long and short energy pulses is transmitted from the control location to the field. A receiving unit in the field responds to the control command by diciphering the code for the control function desired and the switch is moved to the desired position. No other control functions in the field will be initiated by a particular sequentially coded series of pulses.

Operation of Control Panel.--The operator at F Tower would have had to have performed the following moves on July 23 to establish operational protection for train No. 151 and to hold train No. 168 at GATE: (1) if the 2E home signal at GATE was set for proceed and in the fleet mode, pull the 2E signal control button to cancel the fleet mode and next ascertain that the fleet mode white indicating light had extinguished; (2) rotate the 2E control button so that the white marker on the button was up, and (3) pull the 2E signal control button again to cancel the 2E proceed signal and ascertain that the 2E green signal indicating light had extinguished.

Since the fleet mode and the proceed signal aspect can be cancelled simultaneously by rotating the control button so the white marker is up and pulling the button, at his election, the operator could have accomplished both cancellations in one operation. In either event, after the green light was extinguished and during the time it took for the signal to "time out," about 3 minutes, the red signal indicating light also would have remained dark. After the 3-minute timing interval had expired, the stop signal red indicating light would have illuminated, indicating that signal 2E was displaying a stop aspect at GATE and that the "timing out" was complete. Then the PBD control button could have been operated to apply a panel blocking device.

When the dispatcher asked the operator at F Tower to place a PBD on the No. 2 track east, the operator first reported that a PBD was applied west on the No. 2 track. To have accomplished this, he would have had to have rotated the 2WB control button for the PBD west on the No. 2 track so that the white marker on the control button was toward the east and pushed it. An illuminated blue light then would have indicated to him that the PBD was applied west on the No. 2 track and effective. However, when the dispatcher corrected him on this error, he would have had to rotate control button 2EB for the No. 2 track east, so that the white marker on the control button was toward the west, and then pushed the button. The blue indicating light then would have illuminated to indicate to him that the PBD was applied and effective on the No. 2 track east. After the PBD had been applied and the time recorded, the operator could then have copied the format J hold train order and the format D-R train order which gave train No. 151 the right to use the No. 2 track between MARKET and GATE.

For the operator at F Tower to have routed train No. 151 back onto the No. 1 track at GATE, which was the train's normal authorized route, it would have been necessary for him to reverse the No. 12 crossover switches by rotating the switch control lever clockwise about 45° and pushing the code transmit button. After the switch indicated a reverse position by the illumination of the yellow reverse light, the operator would have had to push the signal control button for signal 2W. When the green indicating light illuminated, train No. 151 would have had a proceed signal at GATE to move from the No. 2 track to the No. 1 track through GATE Interlocking.

On July 23, the operator at F Tower did not reverse the No. 12 crossover or clear the 2W signal at GATE for train No. 151 at anytime after the train was reported past MARKET at 10:40 a.m. He said he did not reverse the No. 12 crossover and change the westward 2W signal to proceed because he was going to check with the dispatcher to see if that was what the dispatcher wanted. Checking this step with the dispatcher is not required but it is often done. Amtrak operating rules do not specify how soon a switch or signal will be aligned before a train is due to arrive and require the facility. Operating rule No. 611 reads, "Signals must be kept in stop position except when displayed for an immediate movement. When the route is set, the signals must be operated sufficiently in advance of approaching trains to avoid delay." Rule No. 311 is worded similarly.

Signal and Track Information

Cab signals and train control are in service between Washington and a point just east of GATE Interlocking, about milepost 5.3. If cab signals are not cutout at or after reaching the cab signal cutout point, the train's speed is restricted automatically to 20 mph. When a train reaches the cab signal cutout point, the engineer must forcibly rotate the cab signal cutout switch toward the cutout position until the lead-sealed wire securing it to the stop breaks under tensile stress and the cutout switch can be positioned properly. Safety Board investigators were told that on occasions the lead-sealed wire is difficult to break.

During the investigation, Safety Board investigators learned that some engineers break the lead-sealed wire before the train departs Penn Station to avoid the possibility of delaying the train in the event they may have a difficult time breaking the wire at GATE while the train is moving. Such practice would allow the rotatable switch to be turned easily at the proper time or to be rotated inadvertently by someone accidentally hitting it. Safety Board investigators also were told that some engineers use the locomotive reverser lever to break the seal while the locomotive is still in the terminal at New Haven or New York.

Four main tracks extend from JO Tower eastward past F Tower to Harold and two main tracks extend between Harold and CP Shell. At milepost 6.2, the location of the accident, the tracks are located on a viaduct about 80 feet high. The two Amtrak tracks are numbered 1 and 2 from north to south. Propulsion power is provided by an 11,000 volt a.c. catenary system. A Conrail track, designated track No. 5, and an abandoned track, designated track No. 6, are located south of the No. 2 track.

As the accident site is approached from the west, the Gate distant signal for eastward trains, N.Y. No. 2.48, is located on tangent track 1,348 feet east of Harold and 6,060 feet west of the 2E home signal at Gate. Signal N.Y. No. 2.48 can be seen about 1,300 feet in approach thereto. Between signal N.Y. No. 2.48 and signal 2E, a 3°12' left curve extends about 1,464 feet, followed by a 3°44' left curve which extends about 776 feet to signal 2E. About 1,574 feet of tangent track extends beyond signal 2E, followed by a 3°30' left curve and 3,565 feet of tangent track which extends into the 0°45' left curve where trains Nos. 151 and 168 collided. Automatic wayside signal No. 6.14 on the No. 2 track is 12,823 feet east of signal 2E. Automatic wayside signal No. 1.34 is 10,217 feet east of automatic signal No. 6.14. The grade is 0.72 percent ascending eastward from about the east end of GATE to the point of impact.

Westbound from MARKET, there are a series of 1°00' to 3°10' right and left curves. The 3°10' right curve ends about the west end of the Hell Gate Bridge span. Automatic wayside signal No. 6.14 on the No. 2 track is located at the west end of the bridge. From the end of the 3°10' curve, a tangent track extends westward for about 2,590 feet where the track enters the 0°45' right curve westbound in which the accident occurred. The grade westward from MARKET is predominately ascending to the end of the Hell Gate Bridge. At that point, it descends westward about 0.70 to 0.77 percent into the curve where the accident occurred.

Speed Tapes from Train No. 151.--The speed tape from locomotive No. 936 train No. 151 was produced from a Pulse Electronics, Inc. cassette event recorder. (See figure 9.) The tape indicates that train No. 151 stopped at MARKET for the stop signal, point A, and that it slowed to receive the train order, point B. The speed recorder indicates that after the train left MARKET, the engineer accelerated the train to about 45 mph, point C. At MP 9.09, there is a 1° right curve westbound with a 30-mph

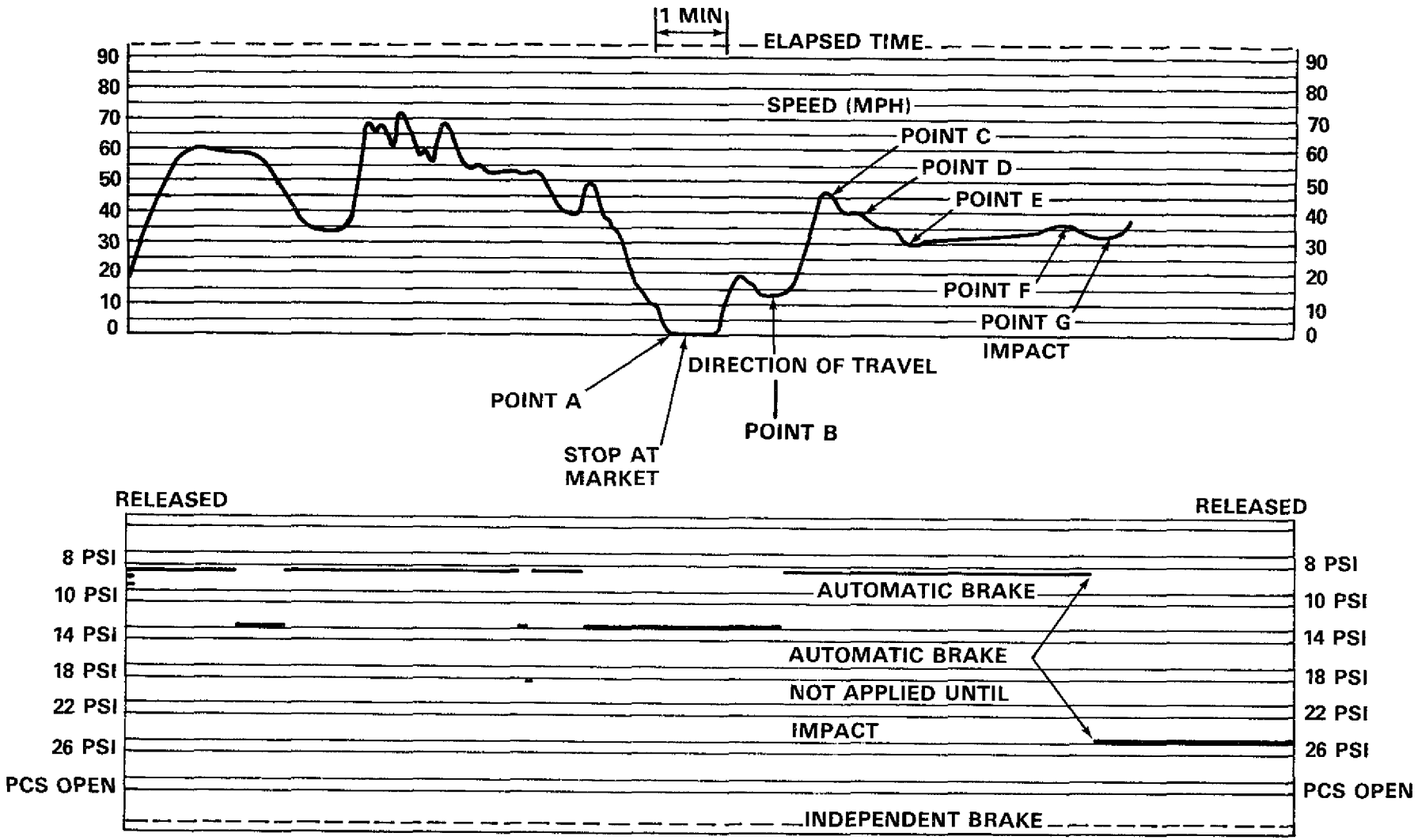


Figure 9.--Speed tape for train No. 151.

permanent speed restriction. The acknowledgement of the 30-mph speed restriction is not shown. The speed was reduced to about 40 mph, point D, which continued to decrease to about 30 mph, at point E. From point E, the speed gradually increased to about 36 mph, at point F. The speed then decreased to about 30 mph, point G , the point of the collision. The elapsed time for train No. 151 between MARKET and the collision point was about 5 1/2 to 6 minutes.

An Amtrak officer who interpreted the speed tape of train No. 151 said the speed tape did not indicate that the emergency brake had been applied just before the collision as stated by the engineer. The emergency brake application could not be indentified on the speed tape.

Speed Tape from Train No. 168.--The speed tape for train No. 168 was produced by a Barco speed recorder. (See figure 10.) The tape indicates that train No. 168 stopped in Penn Station, point A. Upon departing Penn Station, the train accelerated to a speed of about 45 mph, decelerated to about 40 mph, and then further decelerated to about 22 mph, point B. The 22-mph speed represents the speed at which train No. 168 was being operated through Harold Interlocking. After the train passed through Harold Interlocking, the speed was increased to about 43 mph which was maintained for about 1 mile, plateau C. After about 1 mile, the speed was decreased to about 12 mph in the vicinity of GATE, point D. After the train reached the 12-mph speed, the speed was increased to about 30 mph, point E, which was maintained for about 0.3 mile, to the point of the collision. The speed tape indicates a distance of about 6 miles from Penn Station to the collision point.

Meteorological Information

At 10:52 a.m., on July 23, 1984, the National Weather Service reported the weather at La Guardia airport, about 3 miles from the accident site as: broken clouds at 1,900 feet; 3,000 feet overcast; visibility--8 miles; temperature--76° F, wind -- 310° at 9 knots.

Medical and Pathological Information

Passengers described their injuries as facial cuts and bleeding, cuts and bruises on legs and arms, and neck and back injuries. The NYPD reported that 103 passengers, 11 of whom were admitted, were transported to local hospitals for treatment. One hundred and twenty passengers either were treated at the scene or refused treatment. The single fatality, a 39-year-old male, died at 1535 hours on July 25 while in surgery necessitated by injuries sustained during the accident.

A blood sample was taken from the engineer of train No. 168 between 6 and 8 pm. on July 23. The resultant serum 18/ was tested for amphetamines, barbiturates, cocaine, methaqualine, opiates, and phencycledine; none of these drugs were found. The serum also was tested for ethanol, methanol, acetone, actaldehyde, isopropanol and n-propanol; none of these compounds were found.

The engineer of train No. 151 received neck and back injuries as a result of the accident. Two blood samples were taken from the engineer of train No. 151 between 6 p.m. and 10 p.m. on July 23, and a third sample was taken on the morning of July 24. When the samples were tested for barbiturates and Doriden, the results were negative. A test for alcohol also was negative.

18/ Blood residue after the removal of blood cells.

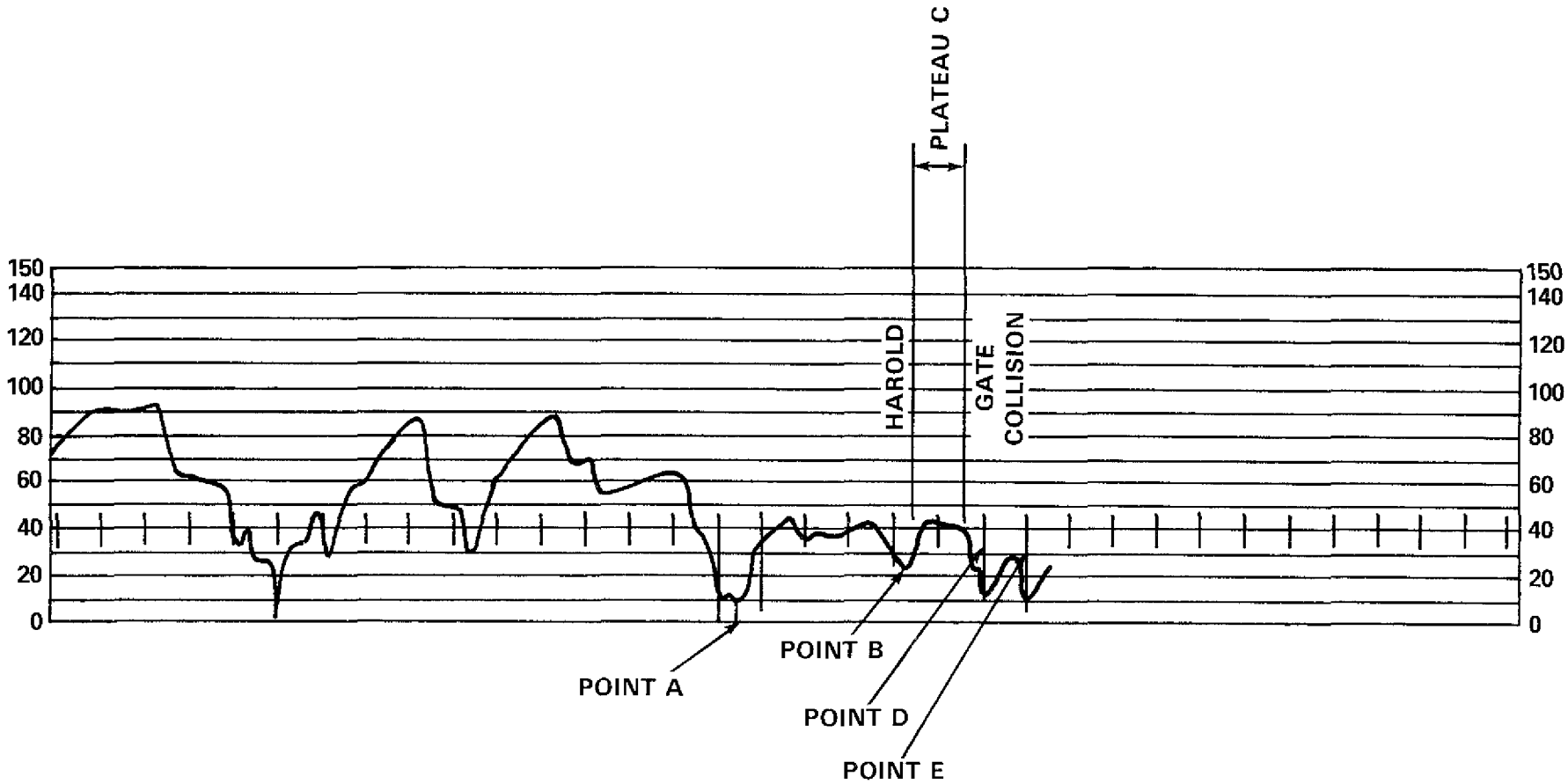


Figure 10.--Speed tape from train No. 168, July 23, 1984.

A urine sample was obtained from the F Tower operator about 4 1/2 hours after the accident and a blood sample about 6 hours after the accident. The urine sample initially was screened for the presence of drugs by Amtrak personnel. When the results were positive for cannabinoids, Amtrak sent urine samples to independent laboratories in the States of New York, North Carolina, and Pennsylvania for verification. The Safety Board obtained and sent a portion of the urine sample to an independent laboratory in Utah for quantitative analysis. 19/ A blood sample was sent by Amtrak to the independent laboratory in Pennsylvania for quantitative analysis.

The test results from the different laboratories were not identical, but it was determined that metabolites of both THC (delta-9 tetrahydrocannabinol) and cocaine were present in the urine. A measurable amount of metabolites of THC and cocaine also were present in the blood. The tests indicated that both marijuana and cocaine were used more than 12 hours before the urine and blood samples were taken. The F Tower operator admitted that he smoked marijuana at a birthday party on July 20. However, he was off duty July 21 and 22. He did not admit to using cocaine during that time, although he said he had used it in the past.

The toxicological report for the train dispatcher was negative for alcohol and drugs.

Survival Aspects

Most of the passengers interviewed by Safety Board investigators indicated that there was no advance warning of the collision. Some said they heard a "clunking" sound just before the impact while others said they felt a light application of the train's brakes just before the impact. In general, the most seriously injured passengers were seated in the lead ends of the head coaches. The severity of injuries diminished toward the rear of the trains.

Passengers were thrown out of their seats into the aisles and into the backs of seats ahead. They stated they had struck other people, chair arms, side walls, disarrayed seat cushions, and seat backs. A number of seats rotated sideways and, in many instances, jammed. Baggage was dislodged from the overhead luggage racks and thrown around the inside of the coaches. Emergency personnel could not recall from which coach the single fatality was removed but only that he was on train No. 151 and in the vestibule of one of the head coaches.

One male passenger said that the ends of the coach in which he was riding were so badly mangled that it was impossible to leave the coach through either end and that he returned to his seat adjacent to an emergency window exit and removed the window in order to get some fresh air into the coach. He said rescue personnel began arriving on scene about 15 minutes after the accident.

Emergency response personnel pooled their resources to facilitate the removal of injured passengers. In coaches with heavy end damage, windows were removed and passengers were taken out through the window openings. There was no difficulty reported in removing the windows. Some passengers were lowered to the street using "cherry pickers" (see figure 11) and tower ladders. Three triage 20/ centers were established

19/ Analysis to measure precisely the amount of various products which are present as opposed to a screen test where the presence of a product is ascertained without specific measurement of the amount.

20/ An assembly station where the injured persons are examined and their priority for treatment is assigned.

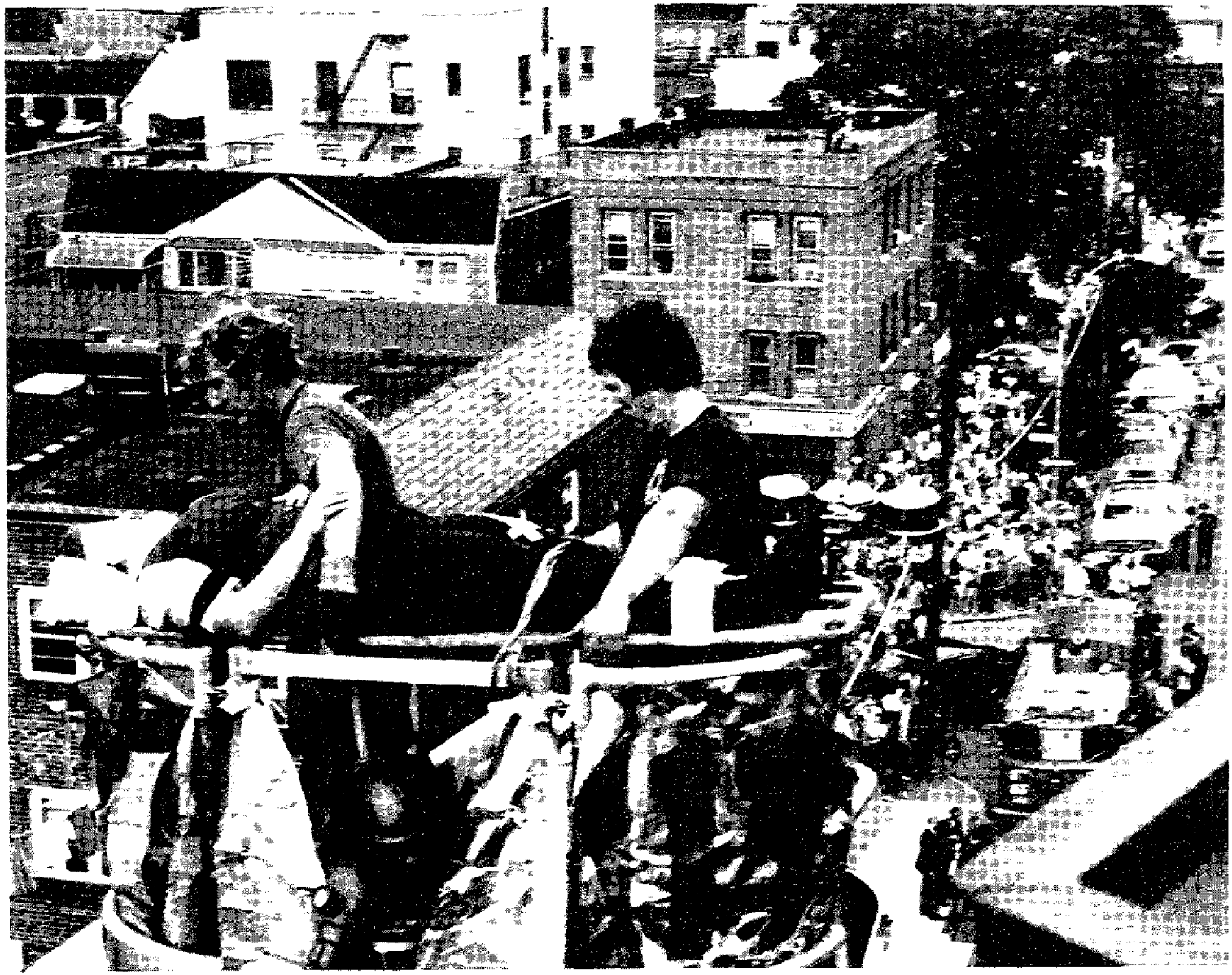


Figure 11.--Injured passengers being removed from the 80-foot viaduct by rescue workers.

through which the injured passengers were dispatched to local hospitals according to the seriousness of their injuries and according to the hospital's ability to handle them. The EMS provided information to emergency personnel as to which hospitals had available space, and ambulances removed the injured persons to nearby hospitals.

Some passengers who were not injured were moved onto the non-derailed rear cars of train No. 168. These cars were coupled to a diesel locomotive and the train was used as a shuttle to and from the 44th Street area where busing facilities were available. Other passengers were transferred to westbound train No. 169 and taken into Penn Station.

Tests and Research

Signals.--On July 23, following the accident, a complete operational check was made of the signal facilities and control functions associated with Gate Interlocking. The tests included but were not limited to:

1. Testing of signal cables for insulation resistance by a Megger 21/
2. Pick-up and drop-away values for signal relays
3. Track circuit shunt tests (0.06 ohm shunt)
4. Signal mechanisms and light functions
5. Route locking circuits
6. Blocking circuits for the No. 2 track east
7. Control functions from F Tower
8. Wiring check against the actual installation
9. Occupancy checks and train progression checks through the interlocking

The results of the tests, including a visual monitoring of the signal system and the installation of a monitoring device, revealed no faults, and the signal circuits and appurtenanes functioned as intended.

Sight Distances.--Between 10 a.m., and 2:30 p.m., on July 31, 1984, representatives of Amtrak, FRA, and the Safety Board conducted sight distance-stopping tests at the collision site. Weather and visibility conditions were similar to the day of the accident, visibility--8 miles, and temperature--85° F to 90° F.

Two test trains were used, AEM-7 locomotive No. 928 with no cars and AEM-7 locomotive 938 with six coaches and one baggage car. The coaches were interchanged during the tests to properly simulate each train.

A plastic ribbon was stretched across the No. 2 track to mark the point of impact. Locomotive No. 928 was moved eastward and stopped near the Hell Gate Bridge. Locomotive No. 938 with seven coaches was moved westward to a point near GATE. As each train approached the collision site, the points were marked at which the engineers of each train could first see the other and determine that their trains were on the same track. For locomotive No. 928 (test train No. 168), the distance was measured as 763 feet west of the collision point, and for locomotive No. 938 (test train No. 151), the distance was measured as 600 feet. The line of sight for each of the locomotive engineers was restricted because of railroad curvature and a grove of trees located about 500 feet west of the collision point.

21/ An instrument to measure cable insulation resistance.

Next, test train No. 151 was moved eastward to MARKET while test train No. 168 was moved westward to Harold. Each train then left its respective location at the same time and they were moved toward each other, duplicating as closely as possible the speed indicated by the speed tapes from trains Nos. 151 and 168. Test train No. 168 passed signal 2E at GATE while it was displaying a clear (three vertical lights) aspect, and immediately afterward the locomotive cab signal dropped to an approach aspect. At that time, test train No. 151 was stopped after it reported that it had passed automatic wayside signal No. 6.14 on the No. 2 track. Test train No. 168 (duplicating the speed indicated on the speed tape produced by train No. 168) continued through Gate Interlocking to the cab signal cutout point where the cab signals were cutout after the engineer broke the lead-sealed wire. When the test train, which was moving at 30 mph, reached the 763-foot marker, time was allowed for the engineer to react before a full service brake application was made. The train stopped at a distance of 472 feet. The following stopping distances were recorded for test train No. 168:

Test No.	Brake Used (Speed Applied)	Stopping Distance (in feet)	Time (in seconds)	Deceleration (MPHPS)*	Remarks
1	Full service (30 mph)	472	16.7	1.8	
2	Emergency (30 mph)	318	11.6	2.59	
3	Full Service (40 mph)	713	19.77	2.02	stopped 212 ft. past marker. Speed 30 mph at marker.
4	Emergency (40 mph)	462	13.61	2.94	

* Rate of deceleration in miles per hour per second.

After the stopping tests were completed, test train No. 168 proceeded to MARKET where locomotive No. 928 and five coaches were assembled to simulate train No. 151. Similar tests were made and the following results were recorded:

Test No.	Brake Used (Speed Applied)	Stopping Distance (in feet)	Time (in seconds)	Deceleration (MPHPS)	Remarks
5	Full service (46 mph)	1,026 (36 mph at marker)	23.58	1.95	426 ft. past marker.
6	Emergency (46 mph)	650 (20 mph marker)	16.88	2.73	50 ft. past past marker.
7	Full Service (30 mph)	570	18.3	1.64	
8	Emergency (30 mph)	343	11.78	2.55	

The speedometer on locomotive No. 928 was calibrated on August 2, 1984, at Wilmington, Delaware. It was accurate at speeds of 102 and 51 mph. The front and rear speedometers on locomotive No. 938 were inspected and tested on July 26, 1984, at Amtrak's Washington, D.C. facilities. The front speedometer was found to be 2 mph slow and the rear speedometer was 4 mph fast with no exceptions taken. The event and speed recorders of the locomotives involved in the accident, Nos. 936 and 924, were not calibrated for speed accuracy because of damage to the equipment.

Time Distance Calculations.--Amtrak provided some time distance calculations on the movement of trains Nos. 151 and 168 as they approached each other on the No. 2 track on July 23. Based on the speeds of the two trains as indicated by the speed charts, 22/ the calculated results were:

Location (MP)	Time (a.m.)	Train
10.01 (MARKET)	10:40	151
9.8	10:40:30	151
9.47	10:41	151
9.14	10:41:30	151
9.09 (sig. 1.34)	10:41:35*	151
8.81	10:42	151
8.48	10:42:30	151
8.15	10:43	151
7.82	10:43:30	151
7.49	10:44	151 (No. 168 passed Sig. 2E)
7.17 (sig. 6.14)	10:44:28*	151
7.16	10:44:30	151
6.83	10:45	151
6.5	10:45:30	151
6.17	10:46	151
6.1	10:46	168
5.25	10:45:30	168
5.60	10:45	168
5.35 (cab sig. c/o)	10:44:30	168
5.1 (GATE Sig. 2E)	10:44	168
3.96 (Sig. NY 2.48)**	10:41:57	168
3.07 (Harold reported 10:40 am)**	10:42	

* Extrapolated times
** Safety Board calculations

Other Information

Disaster Preparedness.--Pursuant to an Executive Order issued by the Mayor, when both the Police and Fire Departments respond to a major catastrophe in New York City, if there is no fire, the Police Department assumes control of the operation. In the event of fire, the Fire Department assumes control. A police sergeant on patrol duty in the area notified the Police Department of the accident within 5 minutes after the collision, and notice of the accident was disseminated to all emergency response personnel. Fire Department and EMS personnel arrived at the scene about the same time. Well over 300 persons were involved in the emergency operation.

22/ Note that the trains Nos. 151 and 168 are converging.

At the time of the accident, there was no formal disaster plan in effect between Amtrak and the New York emergency forces. Rescue efforts were hindered because some emergency response personnel carelessly parked and abandoned their vehicles, creating confusion in the streets below the wrecked trains. (See figure 12.) Also, emergency personnel were unfamiliar with Amtrak's catenary and power distribution system. Power was removed from the catenary system about 11 a.m. and restored over part of the impact area about 12:45 p.m. Power restoration and passenger removal was delayed because the Fire Department would not permit the restoration of catenary power until the request for restoral had been channeled through and approved by the Borough Alarm office. Both Amtrak and the Fire Department procedures require that the restoral of catenary power only be authorized by the same individual who asked for its removal.

Since the accident, Amtrak, the Police and Fire Departments, and the Emergency Medical Services have completed development of and implemented a familiarization and training program which was being planned at the time of the accident. As of November 27, 1983, over 200 members of the emergency forces have completed the program, which is presented as a joint effort by Amtrak and the Long Island Railroad (LIRR). On Tuesdays and Wednesdays of each week different groups of about 25 persons meet to view the slide presentation describing operational procedures and equipment used in Penn Station and Sunnyside Yard. The class includes an explanation of the different electrical systems used to power the equipment and emergency access to the equipment. The class is shown equipment from the LIRR, the New Jersey Transit, and Amtrak, and instruction is given on emergency procedures. Each class is conducted using actual equipment so that first hand knowledge of the structural and operational features can be gained. Finally, the class boards a train and is taken into the East River tunnel where cross passageways are inspected and the group is required to exit through an emergency exit.

Operating Rules and Other Postaccident Changes.--Since the accident, Amtrak has modified its operating rules to require that the engineer and conductor of the train whose rights have been restricted receive a copy of the DR train order which restricts the rights of their train. Amtrak, also has modified its Northeast Corridor track and signal improvement program. At the time of the accident, the plans were to equip the Hell Gate Line with cab signals and train control and to provide for rule 261 operation over that line. As a result of the accident, signal work was expedited on the Hell Gate Line, and on January 10, 1985, the installation of equipment for rule 261 reverse running was completed and rule 261 operation was placed in service between Harold and GATE on tracks Nos. 1 and 2. The signal work to provide rule 261 reverse running between GATE and CP Shell is scheduled to be completed by October 1, 1985.

An event recorder for monitoring operations at GATE has been placed in service since July 23 and similar equipment is planned for other interlockings in the Northeast Corridor to record and preserve a record of the times and movements made at interlocking locations. Also, a redundant blue light to indicate a PBDA has been installed on the GATE control panel since the operator involved in the accident and others had experienced some difficulty in seeing the single blue indicator light.

Amtrak held its own internal investigation of the Queens accident on August 2, 1984, with all of those involved testifying except the engineer of train No. 168. Following the hearing Amtrak restored the F Tower operator to service. He was required to undergo a medical examination, which included a drug screen, and to attend an operating rules instruction class which lasted 3 days. He returned to work at "JO" interlocking in Penn Station, the job he had left when he was awarded the F Tower position.

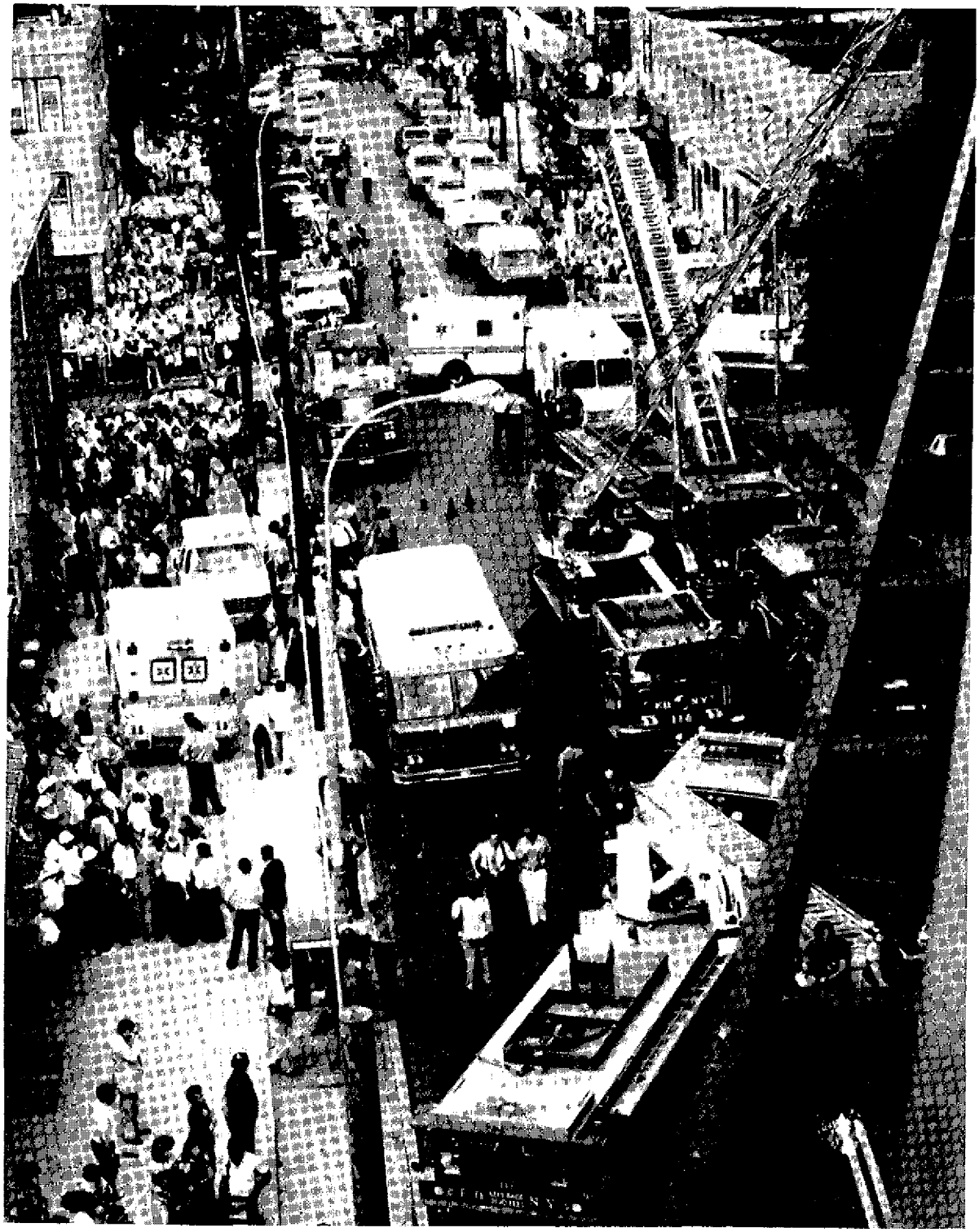


Figure 12.--Street scene below the viaduct at the accident site.

ANALYSIS

Signals

The postaccident tests of the signal facilities at GATE and the remote control panel at F Tower did not reveal any discrepancies in the signal system. Postaccident observations by Amtrak and Federal signal inspectors and the device applied to monitor the interlocking functions associated with signal 2E at GATE did not disclose any malfunctions. The inspection of the interlocking appurtenances at GATE by a signal maintainer about 20 minutes after the accident indicated that track blocks had been applied on the No. 2 track east and west, and the No. 1 track east. The track block on the No. 2 track west was not required, but the F Tower operator apparently had applied it in error and had not removed it. The eastbound home signal 2E was at stop, non-fleeted, and the two crossovers were aligned for a straight main track movement through GATE.

The signal maintainer confirmed that the control positions and the indications on the GATE control panel conformed to the positions of the field equipment. The relief operator, who arrived at F Tower about 45 minutes after the accident, confirmed that the indications and the positions of the control levers/buttons were properly positioned for the interlocking arrangement described by the operator. It should be noted, however, that signal 2E at GATE was designed so that if train No. 168 had passed it while it was displaying a proceed aspect, the signal should have changed to stop. Moreover, because of the location of the collision of trains Nos. 151 and 168, signal 2E would not have changed to proceed after train No. 168 passed, even if the signal had been in the fleet mode. There was no way to determine conclusively from the positions of the control buttons or from the signal equipment at the interlocking whether signal 2E at GATE was at stop or proceed before the passage of train No. 168. From the positions of the white marker on the various control buttons, it appears that the signal was not in the fleet mode and that the panel blocking device control buttons were properly positioned for the applied blocking devices. Based on the findings of the signal maintainer and the relief operator upon their arrival at F Tower, the Safety Board concludes that there were no malfunctions in the signal circuits at F Tower or at GATE on the day of the accident.

Conceivably, between the time of the accident and the arrival of the signal maintainer at F Tower, the F Tower operator could have positioned the controls on the panel to represent the functions that were supposed to have been displayed, but the Safety Board has no basis for such a conclusion. At 10:31 a.m., when the dispatcher directed the operator at F Tower to apply a blocking device on the No. 2 track east, the operator responded "PBDA on 2 west at '30." After he was corrected by the dispatcher, the operator advised him almost immediately that he had a PBDA on the No. 2 track east at 10:32. Based on the postaccident position of the control and signals, the Safety Board concludes that the F Tower operator had made a mistake earlier rather than having misspoken in his report to the dispatcher. At the time the F Tower operator was applying the panel blocking devices, he might have performed one of several actions. Had signal 2E been in the fleet mode, it would have been displaying a proceed aspect because it automatically would have assumed a proceed aspect after the passage of train No. 190 at 9:41 a.m. The operator could have cancelled the fleet mode for signal 2E, mistakenly thinking that he was requesting a stop aspect for the signal and intending that he would apply the PBD after the timing cycle was completed, meanwhile having given the dispatcher the time that he intended to apply the PBD so that the dispatcher could proceed with issuing the train orders. The operator then may have forgotten to apply the PBD after he copied the train orders, and signal 2E would have continued to display a proceed aspect without the operator noting it since cancelling the fleet mode did

not cancel the proceed signal aspect. Alternatively the operator could have cancelled the fleet mode only and then applied the PBD which would have been ineffective. In this case also, signal 2E would have continued to display a proceed aspect.

Irrespective of any other actions taken by the operator, if he had operated the control for signal 2E to display a stop aspect, it would not have mattered whether the PBD was applied or not insofar as the desired result, i.e., displaying a stop aspect for stopping train No. 168 at GATE. Because the panel blocking device blue indicator light was hard to see, the operator may have assumed the PBD was effective when signal 2E actually was displaying a proceed aspect because the signal was in the fleet mode.

If signal 2E had been indicating a proceed aspect when the dispatcher corrected the operator, there was not enough time for the operator to have placed it at stop and wait for the completion of the timing cycle before reporting to the dispatcher 10:32 a.m. as the time for a properly applied PBD. On the other hand, if the operator had followed the prescribed procedures for establishing the block on the No. 2 track east, the design and functioning of the interlocking plant would have prevented his changing signal 2E to proceed for train No. 168.

Based on the evidence, the Safety Board cannot determine conclusively whether signal 2E was at stop, or the operator gave the dispatcher a time for the PBDA before it was applied and then forgot to cancel the signal.

Train Operations

Dispatcher.--The section A train dispatcher proceeded according to prescribed procedures and operating rules when he took the No. 1 track out of service between MARKET and GATE. Even though the regular dispatcher usually allowed trains Nos. 151 and 168 to operate through the GATE-MARKET area before taking a track out of service, the section A extra dispatcher acted within his scope of authority. Train No. 151 should have passed GATE about 10:47 a.m. if it had been routed to the No. 1 track with no delay. Train No. 168 would have arrived at GATE about 10:43 a.m. and should have departed about 10:48 a.m. The dispatcher specifically checked on whether train No. 168 was on schedule and based on the knowledge he obtained at the time, he acted in a manner to incur the least delay possible to either train.

The dispatcher was alert and corrected the F Tower operator when he reported the PBD applied in the wrong direction on the No. 2 track. He followed through on trying to determine the events that were transpiring after he knew there was a problem with trains Nos. 151 and 168. The dispatcher, who had no means of monitoring signal aspects or PBDs at F Tower or GATE, was dependent on the information provided by the F Tower operator as a basis for his decisions. Similarly, he had to rely on the information provided by the train director at A Tower on the departure of trains from JO Tower. Based on the projected departure time of train No. 168 from JO Tower, the Safety Board believes that the section A train dispatcher's decision to run train No. 151 ahead of train No. 168 was well founded based on the information available to him.

F Tower Operator.--In contradiction to the report of the F Tower signal maintainer concerning the use of the fleet/non-fleet mode of the signals at GATE he had observed when he was about the tower, the F Tower operator said that on the day shift he normally did not fleet the signals at GATE because of the potential for track work during daylight hours. The F Tower operator testified that he performed the duties of his job on July 23 as required by the operating rules and established procedures. He responded to the train

dispatcher's directions and supplied the dispatcher with the appropriate information. Also, he responded properly to the manual block rules requirements in conjunction with the operator at MARKET. His responses and performance of his duties in removing the No. 1 track from service and preparing to operate train No. 151 westbound on the No. 2 track between MARKET and GATE were appropriate. The operator's application of a PBD on the No. 2 track west was a redundant move which had no bearing on the events that followed. The fact that initially he made an error in applying the critical PBD and had to be corrected should have impressed on his mind the correct procedure to apply a PBD on the No. 2 track east.

It would have been prudent for the F Tower operator to have aligned the No. 12 crossover and changed the 2W signal to proceed when the MARKET operator reported train No. 151 past MARKET at 10:40 a.m. By not having done so, the F Tower operator ran the risk of delaying train No. 151 at GATE. Also, had he reversed the No. 12 crossover, he would have had a positive assurance that the 2E signal displayed a stop aspect. Under this alignment, if train No. 168 had run past signal 2E at stop, the No. 12 crossover would have been "trailed through" and damaged which would have been positive evidence that signal 2E was at stop.

The operator's reason for not aligning GATE Interlocking for train No. 151 to return to the No. 1 track is weak. Crossing train No. 151 back to the No. 1 track at GATE was the only move the operator could have made without further authority from the train dispatcher. By precedent, the operator had some basis for the manner in which he planned to handle the movement of train No. 151. The practice of an operator checking with the dispatcher in such a situation had been accepted by the dispatchers. Before June 28, the operation of trains against the current of traffic usually had been made between MARKET and Harold. The operating rules do not specify exactly when the route will be aligned and the signal cleared to permit the passage of a train. Based on his testimony, the Safety Board believes that the operator was not sure of the applicable rules and procedures in this case. The Safety Board believes also that the operator should have expected new operating procedures to be developed and be required after GATE was placed into service. Since the return of train No. 151 to the No. 1 track at GATE was provided for in the operating rules, he should have made the move on his own initiative.

In view of the issuance of the July 9, 1984, memorandum by the Division Operator to clarify moves in the accident area, apparently other operators had expressed confusion concerning jurisdictional control of tracks between Harold and GATE, GATE and MARKET, and Harold and MARKET. The GATE remote control unit and the responsibility for operating the GATE Interlocking were new to all the operators at F Tower. However, only the 7 a.m. to 3 p.m. operator represented to Safety Board investigators that he was uncomfortable with the operation and having responsibility for GATE Interlocking. The available evidence indicates that the F Tower operator responded to the operating rules and procedures as he was required under the operating circumstances, even though he had appeared to be uncertain about the applicable manual block rules.

The F Tower operator asked to be allowed to relinquish his assignment at F Tower because he believed it had become more difficult since he bid on it. The installation work to remotely control GATE was in progress when the 7 a.m. to 3 p.m. position was advertised. There were fleet controls for the signals at the remote interlocking and normally operating the GATE interlocking would have made little or no demand on the operator's time. Moreover, the F Tower operator was not required to maintain a train's passing time at GATE or to report it to the train dispatcher unless the train was delayed or unusual circumstances arose. Consequently, the F Tower operator was required to

continue in his awarded assignment because his supervisors did not consider the reasons he gave to justify his request. The Safety Board does not believe there were any safety issues involved with the addition of the responsibility for the operation and control of GATE from F Tower because of the infrequent demand for its uses and the protection afforded by the interlocking circuitry.

In its report involving a head-on collision at Bristol, Pennsylvania, on March 29, 1982, 23/ the Safety Board addressed the problem of employees who were able to pass an operating rules examination with a qualifying grade, but who appeared to lack an understanding of the application of the rules. As a result of it investigation, the Safety Board recommended on September 21, 1982, that Amtrak:

> Review Amtrak's current method of conducting operating rules examinations and review classes to determine if it is adequate to permit employees to demonstrate that they not only know the wording of the rules, but that they understand how the rules are to be applied under actual conditions. If these objectives are not being achieved, restructure the operating rules classes to accomplish this goal. (R-82-95)

On March 31, 1983, Amtrak responded that it was reviewing its methods of instruction and the content and frequency of operating rules classes. Amtrak also indicated that it was providing a comprehensive training program for all train and engine personnel which included the application of operating rules to actual situations. The Safety Board has classified Safety Recommendation R-82-95 as "Closed--Acceptable Action."

The Safety Board is concerned that there still appears to be a lack of understanding of the application of operating rules by some employees even though they obtained a high or, in this case, a perfect score on the operating rules test and believes that the problem should be studied industry wide. In its report of a rear-end collision between two Conrail trains near Saltsburg, Pennsylvania, on February 26, 1984, 24/ the Safety Board again discussed the fact that crewmembers who had received satisfactory passing grades on their operating rules examination did not understand the rules fully or their application. The Board found similiar deficiencies in the training of a train dispatcher in its report of the investigation of a head-on collision at Motley, Minnesota. 25/ The Safety Board believes that rules classes and examinations must be structured so that employees will come to understand the rules and how to apply them rather then simply parroting them. In the interim until industrywide action is taken, the Safety Board urges Amtrak to seek further improvements in its system of rules instruction to require class attendees to demonstrate their knowledge in applying the proper operating rule.

Engineer, Train No. 151.--The evidence indicates that the engineer of train No. 151 observed the requirements of the operating rules with one exception--he allowed the speed of his train to exceed the maximum authorized speed of 40 mph by 6 mph between Market and the point of impact. However, the speed was immediately reduced and there is no indication that the overspeed affected the outcome of the accident.

23/ Railroad Accident Report--"Head-on Collision of Amtrak Trains Extra 769 East and No. 195, Bristol, Pennsylvania, March 29, 1982" (NTSB-RAR-82-05).
24/ Railroad Accident Report--"Rear-end Collision between Conrail Trains OIPI-6 and ENPI-6X, near Saltsburg, Pennsylvania, February 26, 1984" (NTSB/RAR-85/02).
25/ Railroad Accident Report--"Head-on Collision of Burlington Northern Railroad Freight Trains Extra 6760 West and Extra 7907 East, Near Motley, Minnesota, June 14, 1984" (NTSB/RAR-85/06).

The engineer said that when he realized his train was on a collision course with another train he placed the train's brakes in emergency. However, the event recorder from train No. 151 does not support his claim. Instead, the event recorder indicated that the automatic and independent brakes were released. There was no evidence of wheel slide or a sand deposit on the rails to indicate an emergency brake application. The speed tape indicated that the emergency brake was applied as a result of the collision. The lack of an emergency brake application had no appreciable effect on the collision.

Engineer, Train No. 168.--The performance of the engineer of train No. 168 on his westbound trip with train No. 291 was unremarkable. At Penn Station, mechanical department personnel who knew him said that he appeared to be normal. The conductor of train No. 168 said that he did not notice any unusual train handling procedures while the train was en route from Penn Station to the point of the collision. The possibility that the engineer ran past a stop aspect displayed by signal 2E cannot be ruled out because of the lack of eye witnesses and the engineer's continuing inability to testify. There was no evidence disclosed that would suggest that he was impaired in any way.

The speed tape for train No. 168 indicated that it reached speeds higher than those that could be attained with signal 2E at stop with a properly operating train control. The tape indicated that a speed of about 42 mph was attained after the train passed through the interlocking at Harold, and the 42-mph speed was maintained almost constant for a distance of about 1 mile. In that distance, the train would have passed signal N.Y. No. 2.48, the distant signal for GATE Interlocking. The 42-mph recorded speed strongly suggests that signal N.Y. No. 2.48 indicated a clear proceed signal.

If the 2E home signal at GATE had displayed a stop aspect, as the F Tower operator maintains, the distant signal for GATE, (N.Y. No. 2.48) would have displayed an approach aspect, and the prescribed speed through Harold interlocking should have been 20 mph. Assuming that the cab signals and train control on the locomotive of train No. 168 were functioning properly (there being no evidence to the contrary), the signal information picked up from the track by the train control would have allowed the engineer to have accelerated the speed of the train between Harold and the GATE distant signal, N.Y. No. 2.48. At signal N.Y. No. 2.48, however, the engineer would have had to reduce the speed of the train to not more than 30 mph and have been prepared to stop at the next signal, signal 2E. The cab signal in the locomotive cab would have displayed an approach aspect as train No. 168 approached signal 2E. The cab signal would have indicated a restricting aspect about 1/2 mile ahead of signal 2E and the train's speed would have been restricted further to restricting speed (20 mph). The engineer then would have had to reduce the train's speed not to exceed 20 mph to avoid a penalty brake application by the train control. (See appendix B.)

Near the location of signal 2E, the speed indicated on the speed chart showed that the train's speed was reduced from about 42 mph to about 24 mph (point D), then it increased slightly to about 26 mph, and then dropped rather abruptly to 12 mph (point E). If the 2E signal had been clear and had remained clear, there would have been no requirement for the engineer to have reduced the train's speed from 42 to 24 mph. Since the train's speed was reduced, however, it would appear that the aspect of signal 2E suddenly may have changed to a more restrictive signal aspect, i.e., approach. To forestall a penalty brake application by the train control, the engineer would have made a brake application and slowed the train's speed until the speed conformed to the allowable speed for the signal indication. The decrease of speed to 24 mph and then increase to 27 mph could have been caused by a lag in the engineer's releasing the brakes or mechanical action.

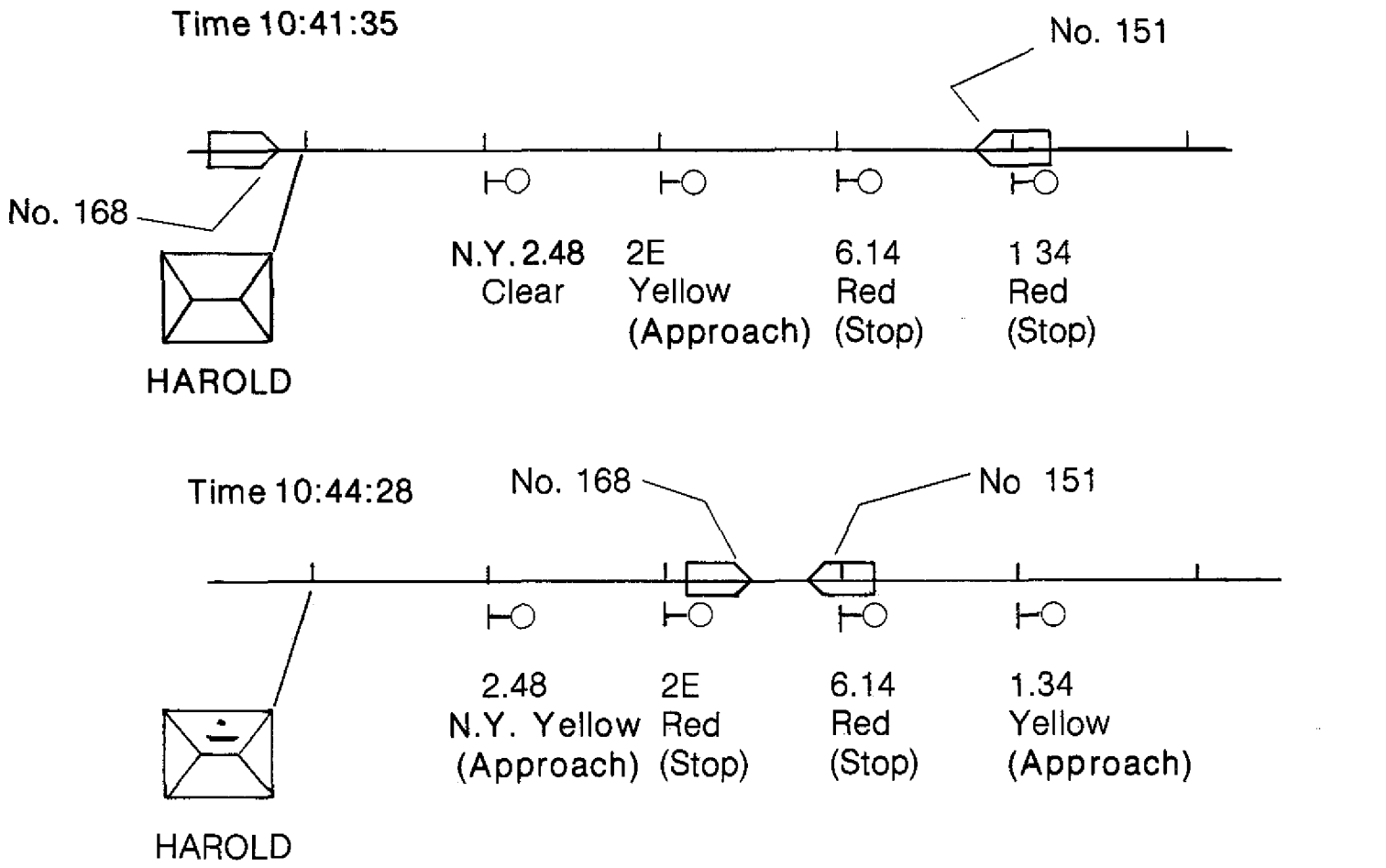
The abrupt decrease of speed from 27 to about 12 mph may have been due to the engineer's recognizing he was reaching the cab signal cutout point and taking anticipated action before the cab signals cutout to forestall a penalty application of the brakes. It would have been logical for the engineer to have made a light brakepipe reduction to hold the train's speed down at this point. Other explanations are that the engineer may have been puzzled about the signal changing to a more restrictive aspect and consequently allowed the train's speed to decrease. Or, he could have been distracted or inattentive momentarily at the instant the signal changed and thought he had passed the cab signal cutout point and applied the brakes.

When a cab signal changes to indicate a restricting aspect, the operating rules allow the engineer to continue to operate his train at restricted speed for a distance equivalent to his train's length. When the engineer has complied with this requirement, he may than operate at the authorized speed which, in this case, was 40 mph. If an approach aspect had been displayed by signal 2E when the train passed the cab signal cutout point, the cab signal aspect would have changed to restricted, allowing the train to operate at 30 mph (restricted speed rule) and to be prepared to stop at the next signal. Because of the inability of the engineer to recall events surrounding the accident, the Safety Board has no conclusive evidence to support any particular hypothesis. However, the speed tape suggests that train No. 168 passed signal 2E with a clear proceed aspect which changed to an approach aspect when train No. 151 passed signal No. 6.14.

According to Amtrak's interpretation of the speed tape, the engineer made a train brake application at the end of plateau C (see figure 12) and released the brake when the speed of the train was reduced to 24 mph. After a short distance, another train brake application was made, probably full suppression, or about 17 psi brakepipe reduction, during which the engineer would have had sufficient time to break the lead-sealed wire on the cab signal cutout switch without being subjected to a penalty brake application if he ran into difficulty breaking the seal at the cab signal cutout point. An Amtrak supervisor speculated that in fact the engineer may have had trouble breaking the lead-sealed wire and that in order to forestall a penalty brake application at the cab signal cutout point, the engineer made another brake application which brought the train's speed down to 12 mph. Once the wire was broken and the cab signals were cutout, the engineer accelerated to about 30 mph, which was maintained until just before the collision. The distance markers on the speed tape are not accurately correlated to actual wayside mileposts so that the exact locations of signals N.Y. No. 2.48 and 2E and the cab signal cutout point cannot be accurately placed; however, the speed reductions appear to correlate closely to these locations.

Based on the time-distance calculations, when train No. 151 passed signal No. 1.34 about 10:41:35 a.m., train No. 168 would have been approaching Harold or passing through the interlocking. (See figure 13.) At that time, signal 2E at GATE should have displayed an approach aspect for train No. 168, and distant signal N.Y. No. 2.48 should have displayed a clear aspect.

When train No. 151 passed signal No. 6.14 about 10:44:28 a.m., signal 2E would have changed to stop, 28 seconds after train No. 168 passed signal 2E at GATE, and the engineer of train No. 168 would not have seen the change. Even if the timing was such that train No. 151 passed signal No. 6.14 before train No. 168 arrived at signal 2E, the change to stop could have been overlooked by the engineer as he was dealing with the move past the cab signal cutout point. If train No. 168 had passed the cab signal cutout point before train No. 151 passed signal No. 6.14, the cab signal aspect on the locomotive of train No. 168 would have changed from approach to restricting, either as a result of the



Aid to Analysis
on Page 40

Figure 13.—Reconstruction of collision sequence.

engineer's cutting the cab signal out or by his running past the cutout point without deactivating the cab signal. At this crucial time, the engineer of train No. 168 would not have known whether the cab signal changed as a result of his action or for another reason.

One of the tests made on July 31 attempted to simulate the movement of the two trains toward each other, but no definitive significance can be attached to the results because of the uncertainties in times and simulated speeds. Based on the information developed from the speed tapes, it would appear that train No. 168 passed signal 2E while it was displaying an approach aspect. However, the actual time and locations of the accident trains were not verifiable and the Safety Board could not determine the signal aspect displayed on the distant signal to GATE or the 2E home signal at GATE.

Because of the varying practices of engineers in breaking the lead-sealed wire on the cab signal cutout switch while the train is still in the terminal, the Safety Board has not accepted Amtrak's interpretation of the speed tape as necessarily being representative of the actual events that prompted the variations in speed by the engineer of train No. 168. Moreover, it is possible the train was operated from Penn Station with the cab signal cut out switch engaged. Mechanical department personnel who inspected the train in the terminal were in the operating compartment of the locomotive and it is possible that if the seal had been prematurely broken someone could have hit the switch inadvertently to cut out the cabs signals. It also is possible that the engineer may have intentionally cut out the cab signal switch knowing he would have to cut it out only 5 miles ahead, and then operated strictly on wayside signal aspects, an almost routine practice among engineers. Since the engineer of train No. 168 was familiar with this run, which he made 5 days per week, he probably would not have been dependent on the cab signal for such a short distance. If the lead-sealed wire had been broken in the terminal, attributing the changes in speed at GATE to breaking the seal in the vicinity of GATE would not be correct. However, an alternative scenario would be that the engineer noticed a change in signal aspect on signal 2E from clear to approach and reacted to slow his train using an erratic braking action. It would seem improbable that an experienced engineer could have seen a signal aspect change to a less favorable aspect in rule 251 territory and have continued to operate the train close to track speed.

Toxicological Analysis

The results of the toxicological test reports on both engineers and the train dispatcher were negative. The toxicological test reports for the F Tower operator were positive for both marijuana and cocaine. In testimony at the Safety Board's public hearing, the operator admitted that he had smoked marijuana, but he said that he rarely used cocaine and never had used either in a manner that the drugs would affect his performance on the job. The exact time of drug use is difficult to determine from test results. However, the interpretation of the toxicological test results by the independent laboratory in Pennsylvania indicated that marijuana and cocaine were used more than 12 hours before the blood and urine samples were drawn.

Expert testimony 26/ given at the Safety Boards Public Hearing in Denver, Colorado, indicated that the levels of marijuana metabolites in the urine fell below 100 ng/ml for the first 24 to 48 hours after usage. The level of marijuana metabolite (28 ng/ml) in the F Tower operator's urine is indicative of use more than 24 to 48 hours

26/ Testimony by Dr. Michael Peat, Associate Director, Center for Human Toxicology, University of Utah, at NTSB Public Hearing, Denver, Colorado, June 7, 1984.

before the sample was taken. The testimony further indicated that the levels of marijuana metabolites (3 ng/ml) in the operator's blood were indicative of recency of use "in terms of days, not hours."

The following psychoactive periods are generally accepted for the two involved drugs:

-- The psychoactive component of marijuana peaks within 15 to 30 minutes after smoking (the predominant mode of administration). The maximum psychoactive period has been reported to occur between 15 to 90 minutes after adminstration. 27/ Research has shown measurable performance degradation for up to 6 hours after use of marijuana.

-- Blood cocaine concentration peaks within 15 to 60 minutes after nasal administration (the predominant mode of administration). As far as can be determined, the psychoactive period follows the blood concentration. Initiation of psychoactive effects may occur earlier than 15 minutes dependent on the dosage. In intravenous administration, the onset of psychoactive effect will be shortened. 28/

Based on these generally accepted psychoactive time frames, the F Tower operator's use of marijuana and cocaine should not have affected the performance of his duties, and he was not under their influences when he reported for duty. However, the long term psychoactive effects or the use of such drugs on the performance of an individual are not fully understood.

The Safety Board believes the use of illegal and illicit drugs by any person serving in a safety-critical position in any transportation mode is unacceptable. It is even more critical when the safety of the public may be affected adversely. Although in this specific accident, the prior use of drugs was not considered to be a causal factor in the accident, the fact that an employee with safety-critical responsibilities who had used two illegal drugs might have gone on duty while they were still psychoactive must be addressed by Amtrak management.

Survival Factors

Much of the impact force was absorbed by the vestibules. The coaches were designed to withstand buff loads of 800,000 pounds and the integrity of the passenger compartments was maintained. The crashworthiness performance in a crash environment of the passenger coaches and locomotives speaks well for the designs and builders of the equipment. If the cars had not been designed to restrict the impact forces to the ends of the equipment and the impact forces had been distributed deeper into each car or locomotive, or if the vehicle had been made more resistant to crash deformation, a greater number of injuries could have been expected.

27/ Dr. Randall D. Baselt (ed.), Disposition of Toxic Drugs and Chemicals in Man, 2nd edition: Biomedical Publications, Davis, California, 1982.
28/ Robert C. Peterson and Richard C. Stillman (eds.), NIDA Research Mongram Number 13: Cocaine 1977, U.S. Government Printing Office, Washington, D.C., 1977.

The vestibules of the head cars were badly crushed and the survival of anyone caught in the vestibules during a crash situation would be problematical. The single fatality, a passenger who died as a result of internal injuries received in the collision, was removed from the vestibule of one of the head cars. Most of the injuries received by other passengers were minor and consisted primarily of cuts and bruises on faces, arms, bodies, and legs. Neck and back injuries were common complaints.

The passengers' seats for the most part remained in place, but some rotated on their pedestals. Passengers suffered head and facial injuries when they struck the seatbacks in front of them and dislodged the seatback cushions. When the seatback cushions were displaced, the piece of sheet metal that serves as part of the headrest support was exposed and became a further hazard. Many passengers were thrown into the aisles and struck each other or the chair arms or sides of the partially rotated seats. (See figure 14.)

Some passengers complained of being struck by loose baggage dislodged from the overhead luggage racks. Amtrak has made several attempts to improve the baggage containment/retention capabilities of the overhead racks, such as installing a vertical lip on the inboard edge of the rack and lateral ridges on the bottoms of the racks. As a result of its investigation of a train collision at Wilmington, Illinois, on July 28, 1983, 29/ the Safety Board recommended that Amtrak:

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

The Safety Board reiterated Safety Recommendation R-84-40 to Amtrak following its investigation of a derailment at Woodlawn, Texas, on November 12, 1983. 30/ On March 13, 1985, Amtrak responded that a web-type retention device was being used in its new prototype single level sleeping cars. Other types of retention devices are being evaluated for Amtrak's prototype coaches which are planned for future construction. Amtrak said it is not planning a retrofit program for equipment in service. However, since the same type of safety hazard manifested itself again in the July 23 accident, the Safety Board urges Amtrak to reconsider its decision about a retrofit program for passenger equipment in service at this time. The present methods for restraining baggage are not adequate and more work needs to be done in this respect on equipment currently in use and the Safety Board continues to hold recommendations R-84-40 in an "Open--Unacceptable Action" status.

Disaster Preparedness

The convergence of the Police and Fire Departments and the Emergency Medical Services personnel at the accident site went smoothly for the most part. The response time and assistance available was commendable. The Police Department assumed general control of the operation and coordinated the activities of the emergency forces

29/ Railroad/Highway Accident Report--"Collision of Amtrak Passenger Train No. 301 on Illinois Central Gulf Railroad with Marquette Motor Service Terminals Inc., Delivery Track, Wilmingon, Illinois, July 28, 1983" (NTSB/RHR-84/02).
30/ Railroad Accident Report--"Derailment of Amtrak Train No. 21 (The Eagle) on the Missouri Pacific Railroad, Woodlawn, Texas, November 12, 1983" (NTSB/RAR-85/01).

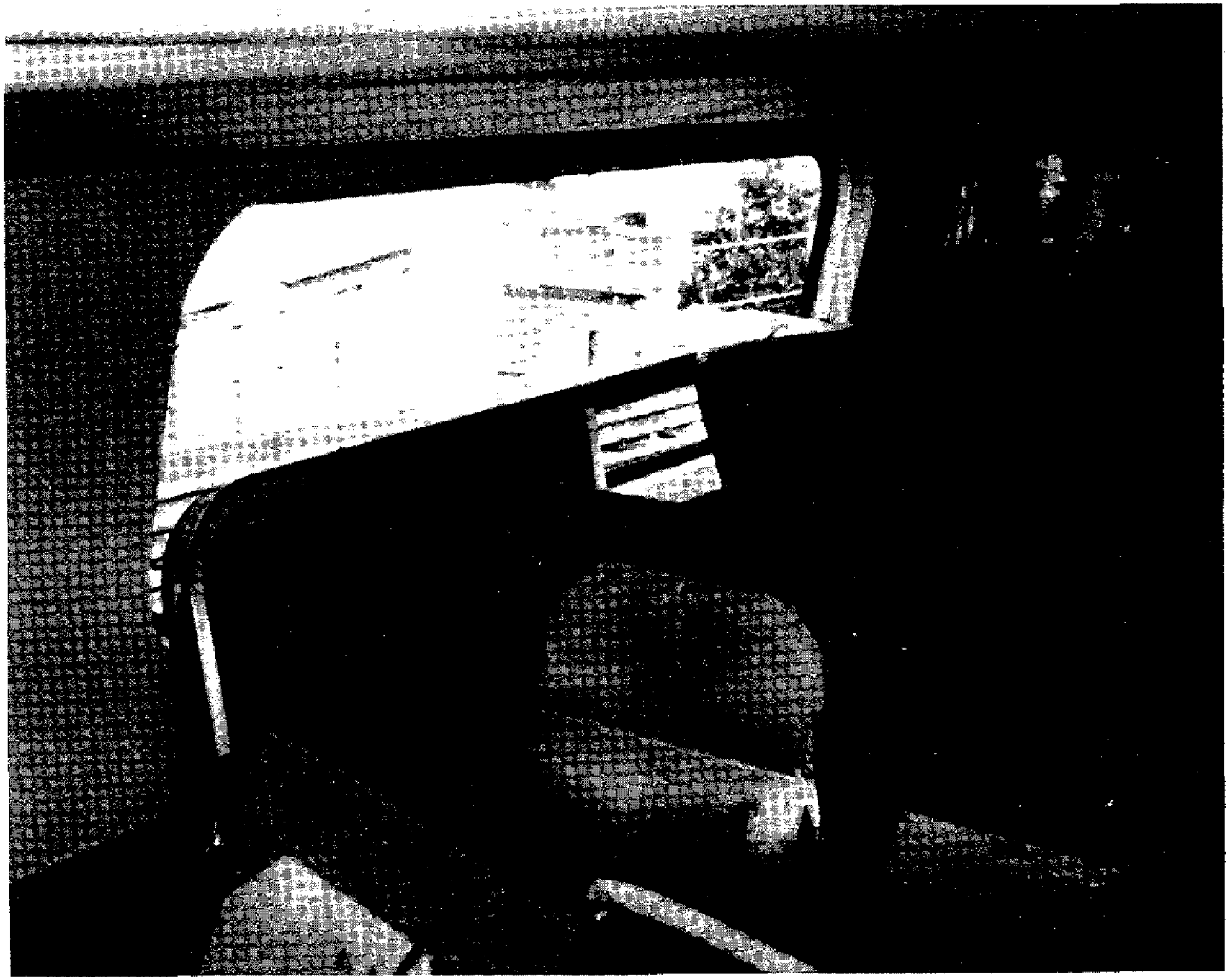


Figure 14.--Interior of coach showing opposed metal frames when seatback is dislodged/removed. Note emergency window removed for egress of passengers.

Amtrak personnel. Some of the difficulties experienced at the accident site were caused by emergency personnel's lack of familiarity with Amtrak's equipment and electrical catenary system.

The rescue operations highlighted two problems that can recur if some advance planning is not done: congestion of traffic arteries and rapid accounting of injured persons. Many responding emergency vehicles were parked in access lanes to the area and the drivers left the vehicles unattended, delaying the movement of ambulances en route to hospitals with injured passengers. In some cases, emergency personnel were unable to account for the numbers of injured persons and the hospitals to which they were dispatched. Both problems can be resolved by planning, by holding joint meetings to discuss procedures, and through mock disaster drills. Such joint meetings could also resolve problems, such as the delayed movement of rescue trains, resulting from a lack of mutual understanding of the operation and control of the propulsion power system.

The Safety Board is pleased to learn of the joint program implemented by Amtrak, the New York City Police and Fire Departments and the Emergency Medical Service since the accident because Amtrak system and procedural information needs to be conveyed to the emergency forces. Conversely, Amtrak's personnel needs to be conversant with the operational procedures and requirements of the emergency forces, and the program should address this reciprocal need. If each party is knowledgeable of the others' capabilities and facilities, needless and potentially harmful delays in transporting injured persons from the disaster area can be eliminated.

Postaccident Changes

The postaccident change in operating rules by Amtrak, to require delivery of a copy of the DR order to the train that has its rights restricted, is responsive to a safety issue developed in the investigation. If the engineer and conductor of train No. 168 had been given a copy of DR order No. 18 which restricted the rights of train No. 168 at GATE, they would have known that train No. 168 was to wait at GATE for the arrival of train No. 151, and regardless of the aspect of signal 2E, in all probability, the accident would have been avoided.

The postaccident change in operating rules by Amtrak to inform the crew of a train that its rights have been restricted is an appropriate backup safety measure, and was a procedure railroads used for many years in the form of a 31 train order. 31/ However, the use of manually delivered train orders increases the exposure of personnel who are involved in delivering the information to hazards attendant on crossing multiple tracks. At some of the interlocking towers where informational orders are delivered, F Tower for example, the operator must cross a number of tracks and electrified third rails to effect delivery of the order. The process also may result in delay of other traffic. The procedure initiated by Amtrak should give added assurance against a train's moving beyond a designated point whether it has a proceed signal aspect or not. Of course the crew of the train with its rights restricted will have to know that the train order has been fulfilled before they can proceed. We hope Amtrak is addressing the problem of giving train crews such notice in multiple track areas, and in areas where there are tunnels. The informational train order could be given to the restricted train via radio to avoid a hazard to personnel. Such a procedure would increase the need for a "clear" radio channel.

31/ The signature of the conductor was required before the order was made complete (see footnote 4.)

Train radio provides a very simple alternative means for a train dispatcher to inform the engineer that the rights of his train are being restricted by train order at a certain location. Information concerning a delay is frequently passed to the engineer after the train has stopped, but the practice has been for the engineer to call a block operator to determine why his train is being delayed. The train crew then passes the information concerning the delay to the passengers.

The crowded radio channel used by Amtrak in the New York area results in frequent problems by interruptions of transmissions. The problem on July 23 was exacerbated by the limited power of the portable transceivers in the New York area. The distress calls from train No. 151 were interfered with "business as usual" transmissions conducted on numerous transceivers, and clearing the channel for emergency calls was difficult. Amtrak should renew action to obtain its own channel to improve operational safety in the New York area and to facilitate emergency response.

The Safety Board is aware that Amtrak has worked with the AAR in an attempt to obtain an exclusive channel for its use in the Northeast Corridor, and that reallocation of channels with other rail carriers could not be accomplished. However, the Safety Board believes that in the interest of safe Amtrak operations in the New York area, the AAR should address vigorously the problem of making a radio channel available for Amtrak's exclusive use in the New York area.

While the use of monitoring instruments at interlocking locations does not necessarily improve the immediate safety of an operation, it does provide a positive check on signal aspects, switch positions, PBDs and the sequence in which operations are performed and on the moves made. Operations can be improved if these records are analyzed to develop improved techniques.

CONCLUSIONS

Findings

1. The train dispatcher had properly removed the No. 1 track from service and had followed applicable rules and procedures in making the arrangements to have train No. 151 operate against the current of traffic on No. 2 main track between MARKET and GATE.

2. The MARKET Interlocking operator was not causally involved in the accident.

3. The signal system at GATE and the control panel at F Tower were found to be operating as intended.

4. There is no evidence to indicate that the F Tower operator failed to apply the panel blocking device properly or to place the eastward home signal at stop or otherwise to comply with the format J hold order.

5. Inspections and tests 20 minutes after the accident indicate that the positions of the blocking device control buttons and the blocking device and signal indication lights agreed with the positions the operator said were established at the time of the accident.

6. The F Tower operator understood the operational requirements of F Tower interlocking and the GATE remote control panel, but he did not exhibit a confidence in his understanding and application of manual block rules.

7. Toxicological test reports for the F Tower operator indicated past use of two illegal drugs (marijuana and cocaine).

8. Based on the generally accepted psychoactive time frame, the F Tower operator's past use of illegal drugs should not have affected his performance.

9. The engineer of train No. 151 was not causally involved in the accident.

10. Because of his injuries, the engineer of train No. 168 is unable to remember events leading up to the accident at GATE on July 23.

11. It is not known when the lead-sealed wire on the locomotive of train No. 168 was broken.

12. Mechanical department personnel said that the engineer of train No. 168 appeared to be alert while he was waiting at Penn Station for the departure time of train No. 168.

13. The signal aspects displayed by the distant signal and the home signal at GATE cannot be determined from the speed indicated on train No. 168's speed tape.

14. The 42-mph speed attained by train No. 168 as it passed signal N.Y. 2.48 and signal 2E suggest that these signals may have displayed clear proceed apsects.

15. The engineer of train No. 168 may have cut out the train control/cab signals before leaving Penn Station and his response to the signal aspects displayed by signals N.Y. No. 2.48 would have been normal as a result of routine operating practices.

16. The engineer of train No. 168 may have been distracted or inattentive when his train passed signal 2E and he was startled when he got a warning for a restrictive signal so that his speed reduction from 42 to 12 mph was abrupt.

17. The signal aspect displayed by interlocking home signal 2E at GATE when train No. 168 passed was not determinable.

18. There were no known defects in the braking systems of the locomotives based on reports of previous use and action after the trains collided.

19. The speeds of trains Nos. 151 and 168 at impact were about 30 mph.

20. The emergency response was handled well, and injured passengers were removed from the site quickly.

21. The locomotives and cars absorbed impact forces in the vestibule and operating compartments in accordance with the design intent.

22. The absorption of impact forces by the crushing of the vestibules reduced the impact forces transmitted to the passengers which resulted in less serious injuries to them.

23. Injuries from flying luggage indicate the need for better methods of securing items stored in the overhead luggage racks.

Probable Cause

The National Transportation Safety Board determines that the probable cause of eastbound train No. 168's continuing past the GATE Interlocking, which resulted in a head-collision with westbound train No. 151, could not be determined.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board recommended that:

--the National Railroad Passenger Corporation:

Modify the coach seats used in Amfleet equipment so that seatback cushions cannot become dislodged when struck and expose surfaces which can cause injuries in accidents. (Class II, Priority Action) (R-85-81)

Apply for an exclusive radio channel for the National Railroad Passenger Corporation's operational use in the New York area. (Class II, Priority Action) (R-85-82)

Develop an operating rules verification procedure that will require employees to demonstrate that they understand the meaning of the rules and can properly derive and apply the correct rules for use in emergency circumstances. (Class II, Priority Action) (R-85-83)

--to the Association of American Railroads:

Review member railroads' current methods of conducting operating rules classes and administering tests for deficiencies, and develop model instruction and testing procedures that will require employees to demonstrate that they not only know the wording of the operating rules but that they understand how the rules are to be applied both in normal and emergency operating conditions. Disseminate the model program to member railroads and encourage them to adopt the program. (Class II, Priority Action) (R-85-84)

Allocate to the National Railroad Passenger Corporation an exclusive radio channel for its operational use in the New York area. (Class II, Priority Action) (R-85-85)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ G.H. PATRICK BURSLEY
Member

May 14, 1985

APPENDIXES

APPENDIX A

INVESTIGATION

1. Notification

About 11:45 a.m. on July 23, 1984, the Federal Aviation Administration's New York office reported that there was a train wreck on Amtrak trackage at Queens, New York. The New York field office of the National Transportation Safety Board was notified immediately and an investigator was dispatched to the scene. At the same time, a member of the Safety Board and the railroad accident investigator-in-charge left the Safety Board's Washington, D.C., headquarters and arrived at the accident scene about 2:30 p.m. Later that afternoon, four other Safety Board investigators arrived in New York to participate in the investigation.

2. Public Hearing

Parties to the investigation, which culminated in a public hearing in New York on October 2-4, 1984 were: Amtrak; the Brotherhood of Locomotive Engineers; the New York State Department of Transportation; the Brotherhood of Railway, Airline and Steamship Clerks; the Federal Railroad Administration; and the American Train Dispatcher's Association. Twenty-two witnesses gave testimony at the public hearing.

APPENDIX B

OPERATING RULES

MANUAL BLOCK SIGNAL SYSTEM

NOTE: Rules 301 to 342, inclusive, will not be in effect except by Special Instructions.

301. Trains operating under the Manual Block Signal System Rules will be governed as follows

(a) Unless otherwise restricted, passenger trains must not exceed 50 MPH, freight trains must not exceed 40 MPH

(b) Trains must not pass over non-interlocked facing point switches until it is ascertained that the route is properly lined

(c) Unless distant signals are in service, trains must approach all home signals prepared to stop

306. When a block station is open at an irregular hour, trains must be notified by Train Order or Bulletin Order Operator must use hand signals in addition to block signals to give required indications until all trains have passed which have not been notified by Train Order or Bulletin Order that the block station is open

308. Open block stations indicate the limits of the manual block, except when a train is authorized by Train Order to run against the current of traffic to an interlocking remotely controlled, the portion of the main track between that interlocking and the first block station or interlocking in the rear will constitute a block for that train Operator must know the train has passed the remotely controlled interlocking before clearing the block

311. Signals must be kept in the position displaying the most restrictive indication except when displayed for an immediate movement

312. Appliances must be operated carefully and only by those charged with that duty If any irregularity affecting their operation is detected, the signals must be displayed to give their most restrictive indication until repairs are made Defects must be promptly reported to the Train Dispatcher

316. (For Absolute Block for following and opposing movements on the same track)

Before admitting a train or engine to a block, the Operator in charge of the block station at the entrance of the block must know that the block is clear and that no other train or engine has been given permission or a signal to enter the block

Signals governing opposing movements, where provided, must display Stop signal The Operator will then display Clear block signal for the train or engine to be admitted to the block

A train or engine must not be admitted to a block unless it is clear except as provided in Rules 327, 333, or by Train Order

318 When a train enters a block, the control of which is divided between two block stations, the Operator must give the train, engine number, and time to the next block station in advance On two or more tracks they must also specify the track

When a train clears a block, the Operator receiving the information must give the record of the train to the block station in the rear

SIGNAL RULES

Movement of Trains by Block Signals

251. On designated tracks specified in the Timetable signal indication will be authority for trains to operate with the current of traffic

261. On designated tracks specified in the Timetable signal indication will be authority for trains to operate in either direction on the same track

211. Clearance Form A must accompany all Train Orders that are physically delivered by the Operator A copy must be prepared for each person who is to receive Train Orders

Clearance Form A must be filled out by the Operator sufficiently in advance to avoid delay, showing, without erasure or alteration, the total number of Train Orders and the number of each Train Order to be delivered Where Clearance Form A is required and no Train Orders are to be delivered, the Operator will write the word "NO" in the space provided

Employees receiving Clearance Form A must, and other members of the crew when practicable will, see that the information shown on Clearance Form A corresponds with the Train Orders received

Operators must forward a copy of each Train Order and Clearance Form A to the Division Operator or other designated officer at specified intervals

221. Unless otherwise provided by Timetable or Train Order, when a Train Order is to be delivered to a train at a Train Order Office, the Operator must place the interlocking signal governing movement of the train in Stop position In addition, where Train Order Signal is in service, Operator must display it in the place provided for that purpose

As prescribed by Rule 200, Train Order Signals are indicated by yellow board by day or yellow light by night attached to the building where Train Orders are delivered, or a flashing letter "O" attached to the mast of the interlocking signal governing movement The yellow board or yellow light Train Order Signal applies only to trains receiving Stop indication on the interlocking signal The flashing letter "O" applies to trains governed by the interlocking signal to which attached, regardless of the signal indication

The interlocking signal must not be cleared for the train involved until the Train Orders have been delivered or the Engineer of the train has acknowledged the Train Order Signal The Engineer must acknowledge the Train Order Signal by two short sounds of the engine whistle or horn, or by radio

At locations where Train Order Signals are not in service, the Operator is responsible for keeping the last interlocking signal in Stop position until the Engineer acknowledges that Train Orders are to be received

The Engineer's copies of the Train Order and Clearance Form A will be handed on the engine and the Conductor's copies on the train

When Train Orders are delivered to a moving train, the speed of the train must be reduced sufficiently to enable the Operator to deliver the Train Order If delivery is not effected on the engine, the train must be stopped

When a Train Order restricting the movement of a train covers a portion of track between the Train Order Office and the next point where the train can be held, the Operator must stop the train before delivering the order

Engineers and Conductors must read all Train Orders immediately after they are received

x x x x x

Format J Train Order
Holding Order

(1) *Hold No 2 Eng 592*
(2) *Hold all trains*
(3) *Hold westward trains*
(4) *Hold all trains clear of No 1 track between A and B*
(5) *Hold all southward trains clear of No 3 track between A and B*

When a train has been so held, it must not proceed until the Train Order to hold is annulled or a Train Order given to the Operator in the form *No 302 Eng 933 may go on No 1 track at A*

These Train Orders will be addressed to the Operator and acknowledged in the usual manner except that the response "complete" must not be given by the Train Dispatcher until the Operator has placed the fixed signal at Stop for the track and in the direction of the approaching train at the point at which the train is to be held

The direction and the time of the last train in the block must be recorded in the Train Order Book

Panel Blocking Device must be activated or Approved Blocking Devices applied to switch or signal levers governing all routes to track affected and recorded on the block sheet and in the Train Order Book

x x x x x

x x x x x

Format W Train Order
Providing for Maintenance Work Obstructing a Track

(1) *No 1 track out of service between A and B but may be used with authority of Foreman Johnson*

For use when one block is to be taken out of service

(2) *No 2 track out of service between A and B and between B and C but may be used with authority of Foreman Johnson*

For use when two blocks are to be taken out of service and intermediate interlocking is to be retained in service

(3) *No 3 track out of service between A and C but may be used with authority of Foreman Johnson Interlocking Rules at B on No 3 track are not in effect*

For when two blocks and intermediate interlocking are to be taken out of service

(4) *No 4 track out of service between A and a barricade erected at (mile post, station name, signal bridge or switch) but may be used with authority of Foreman Johnson*

For use when only a portion of a block is to be taken out of service

Examples (1), (2), (3) and (4) to be used in accordance with Rules 829 to 829h

x x x x x

Format D-R Train Order
Providing for Movement Against the Current of Traffic

(1) *No 1 Eng 461 has right over opposing trains on No 2 track D to F*
(2) *After No 4 Eng 981 arrives No 1 Eng 461 has right over opposing trains on No 2 track C to F*

Before a train is authorized to move against the current of traffic a Format J Train Order must be issued to location(s) where opposing movements can be restricted and the track on which movement is to be made is known to be clear of opposing movements

The designated train must use the track specified between the points named.

204 Train Orders must be addressed to those who are to execute them naming the place at which each is to receive his copy Those for a train must be addressed to the Conductor and Engineer and also to anyone who acts as its pilot Train Orders issued to track cars must be addressed to Driver TC A copy for each employee addressed and for the Engineer of each helping engine coupled ahead of the train must be supplied by the Operator

When practicable Conductors and Engineers must show Train Orders to other members of the crew who will when practicable, remind Conductor and Engineer of the requirements of Train Orders

The Engineer of each engine taken on at a point where no Train Orders are delivered to a train, must be advised by the Conductor or Engineer of that train of all Train Orders previously received affecting the train in the territory to be covered by the additional engine

x x x x x

A Station Record of Train Movements must be maintained for each block station on which information as to all movements within blocks under their jurisdiction must be recorded by the Operator

321. Operators must, as far as practicable, observe each passing train and note that the marking device is properly displayed. If marking device is not properly displayed on the rear car, Operator must consider that the rear portion of the train has not yet arrived, and must immediately contact the Train Dispatcher for instructions

322. Should a train pass a block station with any indications of conditions endangering the train or a train on another track, the Operator must immediately attempt to contact that train and other trains involved, notify the Operator at the next block station in advance, and each must display Stop signals to all trains that may be affected Unless authorized by the Train Dispatcher, they must not permit any train to proceed until it is known that its track is not obstructed

325. When there is an obstruction between block stations, notice must be given to the nearest Operator or Train Dispatcher

An Operator informed of any obstruction in a block must immediately attempt to contact any train involved, notify the Operator at the other end of the block, and each must display Stop signals to all trains that may be affected Unless authorized by the Train Dispatcher, they must not permit any train to proceed until it is known that its track is not obstructed

326 When a train clears the main track at a hand-operated switch or a remotely controlled interlocking switch, the Conductor, Engineer, or member of their crew when authorized by the Conductor or Engineer, must report clear to the Operator

327. A train must not enter a block, foul the main track or cross from one main track to another without proper block signal indication, or permission from the Operator and condition of the block Before authorizing movement, the Operator must obtain control of the block(s) to be used

Unless directed by the Train Dispatcher, the Operator must not give permission to a train to enter a block at a hand-operated switch or crossover, or foul the main track on which another train is moving or has been authorized to move in the direction of such switch or crossover from the next block station or interlocking

A train having passed beyond the limits of a block must not re-enter that block without proper block signal indication, or permission of the Operator and condition of the block

A train must not make a reverse move within the limits of a block without permission and protection from the Operator, when authorized by the Train Dispatcher. If communication is not available to secure permission, or Operator cannot provide the necessary protection, a train may make a reverse move within the limits of a block when preceded by a flagman who must be prepared to stop an opposing movement traveling at Restricted Speed

Information concerning the block received by the Conductor or Engineer must personally be given to other members of the crew when practicable

The Operator may permit a train to enter a block at Restricted Speed behind a train a sufficient distance to clear main track switch, in order to proceed in the opposite direction

328 Unless otherwise directed, when two or more trains have been coupled and so move past any block station, they must be separated only at a block station and the Operator notified

When coupled trains are separated, the Operator must regard each portion as an independent train

329. When necessary to stop a train for which other than a Stop signal has been displayed and accepted, the Operator must give hand signals in addition to displaying the Stop signal

331. A train must not pass a block signal indicating STOP, except when authorized by Clearance Permit Form C issued by the Operator, when authorized by the Train Dispatcher Clearance Permit Form C must not be issued until the train has stopped at the signal

333 When an Operator is unable to communicate with the next block station in advance, he must stop all trains approaching in that direction Should no cause for detaining a train be known, it may then be permitted to proceed by Train Order

334. Where fixed signals capable of displaying Clear Block aspect are in service, they must be used Where such signals are not in service, the Operator must use hand signals, radio communication or telephone communication to convey Clear Block indication A proceed hand signal with a green flag or light indicates Clear Block Radio or telephone communication may be used to convey Clear Block indication only when conditions prohibit the use of hand signals

The Operator must not convey Clear Block indication until he is assured that the route is properly lined and that the interlocking signal, when provided, is displayed

A train approaching a block station on a track for which there is no fixed manual block signal must stop and ascertain from the Operator the condition of the block ahead When a hand signal or radio communication is used by the Operator to convey Clear Block indication, the stop is not required

339 If a Stop signal is disregarded, the Operator must immediately attempt to stop that train and other trains involved, and notify the next open block station in advance and the Train Dispatcher

340 To open a block station, the Operator must first notify the Train Dispatcher and then obtain from the Operator in charge of the next block station in each direction the record of trains that are in the extended block or blocks over which the Operator is taking charge and enter them on his block record

When trains which were in the extended block or blocks when the block station was opened and which had passed his block station before it was opened clear the block in advance, the Operator must so advise the Operator in charge of the block in the rear

Unless otherwise directed, trains must not be admitted to a block in the direction of a closed block station after the time

specified for it to be opened until it is known that such block station is open

340a Trains in an extended block at the time specified for an intermediate closed block station to be opened must identify their train to the Operator before accepting a signal to proceed at that station

341 A block station must not be closed except as provided for by Timetable, General Order, Bulletin Order, or Train Order

342 A block station must not be closed until the block in each direction is clear of trains moving under a block signal indication that would not be proper for the extended block

To close a block station, the Operator must notify the Operator in charge of the block station in each direction that his block station is being closed and give the record of trains and track cars in the extended block

X X X X X

X X X X X

CAB SIGNAL SYSTEM

NOTE: Rules 550 to 563, inclusive, will not be in effect except by Special Instructions

550 The Cab Signal System apparatus must be tested at least once in each 24 hour period except when a single trip exceeds 24 hours in which case the original test shall be valid for the entire trip The test must be made prior to departure of an engine from its initial terminal to determine if apparatus is in service and functioning properly When Cab Signal apparatus is cut out or de-energized after departure test has been made, it must be tested again prior to entering equipped territory Engines dispatched from points in Cab Signal territory to points where test circuits are not provided must have Cab Signal apparatus cut in for the entire trip Testing sections at locations other than terminals will be specified in the Timetable Special Instructions

When test of Cab Signal System apparatus is made by an employee other than the Engineer, the prescribed form stating that the Cab Signal System apparatus has been tested must be filled out in its entirety and must accompany the engine to its final terminal The Engineer, after taking charge of the engine, must assure himself that Cab Signal System apparatus is energized and that the audible indicator will sound when acknowledging device is operated If the Cab Signal System has been de-energized or the audible indicator fails to sound when the acknowledging device is operated, the Engineer must not enter equipped territory and must communicate with the Train Dispatcher and advise him of the situation

A departure test of the Cab Signal System apparatus is required as follows

(a) On single unit engine equipped for operation in both directions, test must be made from both ends
(b) On engine consisting of two or more units, test must be made from front end of leading unit and rear end of trailing unit
(c) When test equipment is not available at a point where an intermediate unit will be required to become a lead unit, this unit must be tested at the initial terminal and the prescribed form filled out and placed on the engine

When a departure test cannot be made due to failure of test equipment, engine may be dispatched provided inbound operating test indicated that the Cab Signals were functioning properly after last trip or that defects, if any which existed have been corrected and the proper record made The prescribed form must be used and signed by the Enginehouse Foreman or his representative who must also verbally notify the Engineer of the details

When necessary enroute to operate from an equipped unit or end that had not been given a departure test, the Cab Signals must be considered inoperative, and Rule 554 must be observed

551. The Cab Signal System is interconnected with the fixed signal system so that the Cab Signal must conform with the fixed signal within three seconds after the engine passes fixed signal governing the entrance of the engine or train into the block in the direction for which the track and engine are equipped and Engineer will be governed as follows

(a) When Cab Signal and fixed signal conform when entering the block, a change of cab signal aspect will indicate conditions affecting movement of train in the block, and cab signal will govern

(b) When Cab Signal changes from Clear to Approach Medium between fixed signal locations, trains exceeding Medium Speed must at once begin reduction to that speed, unless otherwise authorized by next fixed signal indication

(c) When Cab Signal aspect changes to Restricting, the Engineer must take action at once to reduce train to Restricted Speed

(d) When Cab Signal aspect changes from Restricting to a more favorable aspect, speed must not be increased until train has run its length

(e) If the Cab Signal and fixed signal do not conform when train enters the block, the more restrictive signal will govern The Engineer will notify the Train Dispatcher or Operator by radio or by message as soon as possible without delaying the train, giving location and track on which non-conformity occurred

(f) When Cab Signal aspect "flips" (momentarily changing aspect and then returning to original aspect), Engineer will, by radio or as soon as possible without delaying the train, forward a message in the following form to the Train Dispatcher
Cab Signal flipped from *(state aspect)* to *(state aspect)* on No ___ track at *(signal bridge or MP no)*, or between *(designate points if multiple occurrence)*
When the "flip" holds for a duration which required Cab Signals be acknowledged, Engineer must so state when reporting occurrence

(g) The Cab Signal apparatus will be considered as having failed when
(1) The audible indicator fails to sound when Cab Signal changes to a more restrictive aspect
(2) The audible indicator continues to sound although Cab Signal change was acknowledged and speed of train has been reduced to speed required by Cab Signal indication
(3) The Cab Signal fails to conform at two fixed signal locations in succession
(4) Damage or fault occurs to any part of the Cab Signal apparatus

When Cab Signal apparatus has failed, the train will proceed governed by Rule 554 and a report must be made to Train Dispatcher or Operator by radio or if not so equipped, at first point of communication where stop can be made without excessive delay

Engineer must report reason that Cab Signal apparatus was considered as having failed and location where failure occurred on the prescribed form

If the Cab Signal has authorized a speed greater than the speed authorized by the fixed signal, the Engineer, in addition to notifying the Train Dispatcher and making report on prescribed form, will verbally advise the Enginehouse Foreman or his representative on arrival at engine terminal so that the engine may be withheld from service and equipment not disturbed

When the Cab Signal apparatus has failed the audible indicator may be cut out if it continues sounding after being acknowledged

(h) Cab Signals will not indicate conditions ahead when engine is
(1) Moving against the current of traffic, except as provided in the Timetable Special Instructions
(2) Pushing cars
(3) Not equipped with Cab Signal apparatus for backward movement and is running backward

552 When the Cab Signal portion of the wayside signaling equipment is inoperative, the Train Dispatcher or Operator when authorized by the Train Dispatcher must notify the Engineer and designate the limits of the area affected by such malfunction Movements within the designated limits shall be made as prescribed by Rule 557 The Speed Control System of the engine must be cut-out, but the Cab Signal Apparatus must remain cut-in

553 Trains from a connecting Railroad must be equipped with a Cab Signal System in operative condition or as specified in Timetable Special Instructions The Cab Signal System must have been tested in compliance with Rule 550

When a train from a connecting Railroad has experienced a Cab Signal failure en-route from its Initial Terminal, the Engineer must contact the AMTRAK Train Dispatcher or Operator, who will control movement, before entering onto the Northeast Corridor The Engineer will inform the AMTRAK Train Dispatcher or Operator of the condition of his Cab Signal System and be governed by instructions

554. The movement of a train equipped with cab signals not in operative condition for direction of movement is prohibited, except when cab signal failure occurs after leaving engine terminal

If a failure of the cab signal apparatus occurs, as described in Rule 551, the Train Dispatcher or Operator must be promptly notified and be given any pertinent information regarding the failure The train may proceed according to signal indication but not exceeding 40 MPH Trains must not pass a signal displaying a Stop and Proceed aspect unless authorized by the Train Dispatcher to do so

When authorized by the Train Dispatcher the train may proceed as provided for in Rule 557

555. The movement of a train not equipped with Cab Signal System apparatus is prohibited except as provided for in Timetable Special Instructions

Movements authorized by Timetable Special Instruction shall operate at Restricted Speed and be governed by fixed signal indication When authorized by the Train Dispatcher the train may proceed as provided for in Rule 557

557. Movements being made as provided for in Rules 552, 554 or 555 may be authorized by the Train Dispatcher to proceed at Normal Speed, not exceeding 79 MPH and be governed by fixed signal indication A train must not pass a signal displaying a Stop and Proceed aspect unless authorized by the Train Dispatcher to do so

558. When the Cab Signal System apparatus has failed, the apparatus shall be considered inoperative until engine is cut off for repairs and has been tested and found to be func-

tioning properly Authority given to an Engineer by the Train Dispatcher or Operator for movement of his train by Cab Signal System rules will remain in effect for entire trip Train Dispatcher will notify connecting Division or Railroad of any such authority given to a train

559 Train Dispatcher will record on the train sheet the movement of trains with inoperative Cab Signals and the movement of any train that is not equipped with a Cab Signal System Where Cab Signal System rules are in effect, Operators will make a record of all such moves on the block sheet and indicate those movements given authority to operate as provided in Rule 557

In the application of Rule 552, Train Dispatcher and Operators involved will record the limits of the affected area and indicate those movements given authority to operate as provided in Rule 557

561 Engineer, in addition to verbally reporting flips, failures, non-conformities, and other unusual occurrences of Cab Signal System apparatus as required by these rules, will report the same occurrences on the prescribed form

562 When the unit from which the train will be controlled in equipped with Cab Signals and not Speed Control or Train Control, the Engineer will advise the Conductor and other members of the crew before starting trip When the Train Control or Speed Control apparatus fails or is cut out enroute, the Engineer must notify the Conductor and other members of the crew as soon as possible without causing undue delay to the train The train or engine may proceed governed by Cab Signal (when known to be in operative condition) and fixed signal indications Engineer will report failure of Train Control or Speed Control to Train Dispatcher or Operator by radio Report must also be made on the prescribed form

APPENDIX C

TRAIN ORDERS AND FORMATS

FORM 19

NORTHEAST CORRIDOR
TRAIN ORDER NO. 18

July 23 1984

FORM 19

TO Opr

AT F

No 151 Engine 936 has eight cars opposing Trains on No. 2 Track Market to Date

RAH

Annulled by 19 Order No 20 dated July 23

MADE Complete TIME 1034 A M OPERATOR Rosen

NEC 262(5/82)

FORM 19

NORTHEAST CORRIDOR

TRAIN ORDER NO. 16

July 23 19 84

FORM 19

TO Opr

AT J

No 1 Track out of service between Market and Gate but may be used with authority of Foreman Murdaugh.

RAH

PBDA East on 1 at 1001 Am

PBDR East on 1 at 122 PM

Order No 23 annulled order No 16 at 109 Pm

MADE Complete TIME 1003 A EST OPERATOR Rosemond

MEC 262(5/82)

FORM 19

NORTHEAST CORRIDOR
TRAIN ORDER NO. 17

July 23 1984

FORM 19

TO Opr

AT F

Hold all Eastward trains clear of No 2 Track between Gate and Market

RAH

PBDA 1032Am

MADE Complete TIME 1033 A M OPERATOR Rosemond

NEC 262(5/82)

FORM A

NORTHEAST CORRIDOR
CLEARANCE FORM A

FORM A

July 23 1984

To CJ E 76.151 eng 936 at Market

I have 1 orders for your train

Order No 18 Order No Order No

Order No Order No Order No

Order No Order No Order No

have been delivered and there are no further orders for your train

Conf Operator

This form does not affect any orders you may have received.

NEC 1250 (8/83)

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