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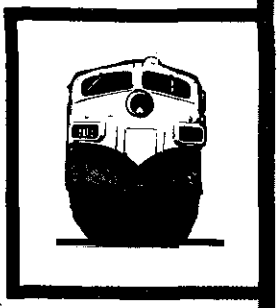

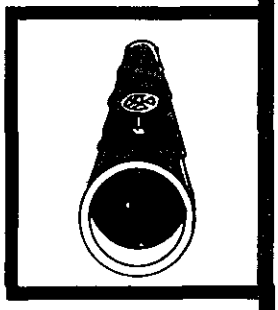

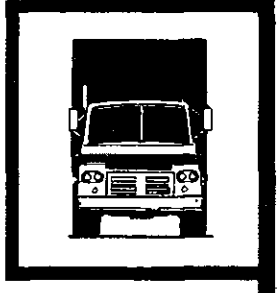

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

COLLISION OF AMTRAK TRAIN 66, THE NIGHT OWL WITH ON-TRACK MAINTENANCE-OF-WAY EQUIPMENT CHESTER, PENNSYLVANIA JANUARY 29, 1988

NTSB/RAR-89/01

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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15 Supplementary Notes

16 Abstract About 12 36 p m eastern standard time on January 29, 1988, northbound National Railroad Passenger Corporation (Amtrak) train 66, The Night Owl, struck maintenance-of-way equipment on track 2 in Chester, Pennsylvania The engineer of train 66 received serious injuries, and 8 crewmembers and 15 passengers received minor injuries The estimated damage as a result of this accident was $3,397,215

The major safety issue in this accident concern the manner in which Amtrak provides protection from intrusions onto out-of-service tracks The specific issues include Amtrak's use of blocking devices and train orders to take tracks out-of-service, Amtrak's use of insulated maintenance-of-way equipment, the lack of redundancy to the operating rules to provide protection for out-of-service tracks from undesired intrusions, the failure of the tower operator and train dispatcher to comply with Amtrak's operating rules, Amtrak efficiency checks conducted on tower operators and train dispatchers, Amtrak's selection standards and procedures for the position of tower operator, and the injury-producing features within the interior of Amtrak passenger cars

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The National Transportation Safety Board determines that the probable cause of this accident was the failure of the third-shift tower operator at Hook tower, because of impairment by drugs or distraction or both, to operate the 7 switch to allow train 66 to crossover from track 2 to track 1 and the failure of Amtrak to provide positive protection for on-track equipment and out-of-service tracks Contributing to the accident was Amtrak's failure to adequately monitor the activities and job performance of the tower operator

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APPENDIXES

EXECUTIVE SUMMARY

About 12:36 p.m. eastern standard time on January 29, 1988, northbound National Railroad Passenger Corporation (Amtrak) train 66, The Night Owl, struck maintenance-of-way equipment on track 2 in Chester, Pennsylvania. The engineer of train 66 received serious injuries, and 8 crewmembers and 15 passengers received minor injuries. The estimated damage as a result of this accident was $3,397,215.

The major safety issue in this accident concern the manner in which Amtrak provides protection from intrusions onto out-of-service tracks. The specific issues include:

- Amtrak's use of blocking devices and train orders to take tracks out-of-service;
- Amtrak's use of insulated maintenance-of-way equipment;
- The lack of redundancy to the operating rules to provide protection for out-of-service tracks from undesired intrusions;
- The failure of the tower operator and train dispatcher to comply with Amtrak's operating rules;
- Amtrak efficiency checks conducted on tower operators and train dispatchers;
- Amtrak's selection standards and procedures for the position of tower operator; and
- The injury-producing features within the interior of Amtrak passenger cars.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the third-shift tower operator at Hook tower, because of impairment by drugs or distraction or both, to operate the 7 switch to allow train 66 to crossover from track 2 to track 1 and the failure of Amtrak to provide positive protection for on-track equipment and out-of-service tracks. Contributing to the accident was Amtrak's failure to adequately monitor the activities and job performance of the tower operator.

As a result of its investigation, the Safety Board issued safety recommendations to Amtrak and the American Railway Engineering Association.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

COLLISION OF AMTRAK TRAIN 66, THE NIGHT OWL, WITH ON-TRACK MAINTENANCE-OF-WAY EQUIPMENT CHESTER, PENNSYLVANIA JANUARY 29, 1988

INVESTIGATION

Events Preceding the Accident

About 10 p.m. on January 28, 1988, a maintenance-of-way track foreman for the National Railroad Passenger Corporation (Amtrak) requested that track 2 between Hook tower (at Marcus Hook, Pennsylvania) north to Phil interlocking (Philadelphia, Pennsylvania) be taken out of service so that track work could be performed. (See figure 1.) At 10:03 p.m., the second-shift Hook tower operator[1] placed blocking devices[2] on the lever that operates the 14L signal lever and the levers that operate switches 15 and 23 (see figure 2); he also requested and received from the second-shift dispatcher,[3] a train order taking track 2 out of service north from Hook tower to Phil interlocking. (See appendix C.) The second-shift tower operator issued a copy of that train order, No. 920, to the track foreman and retained a copy.

At Hook, the track foreman directed the crew of the on-track equipment to bring the equipment from a storage track to main line track 2. However, because the crew could not start the tamper equipment, the track foreman decided to send another

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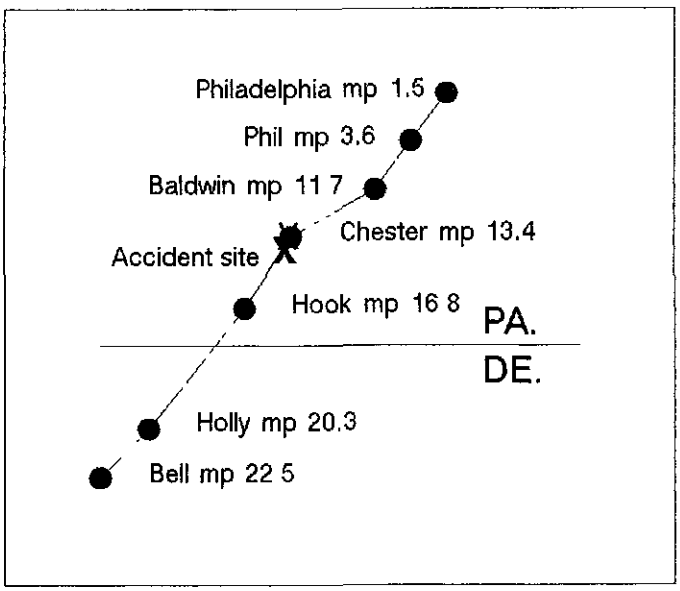
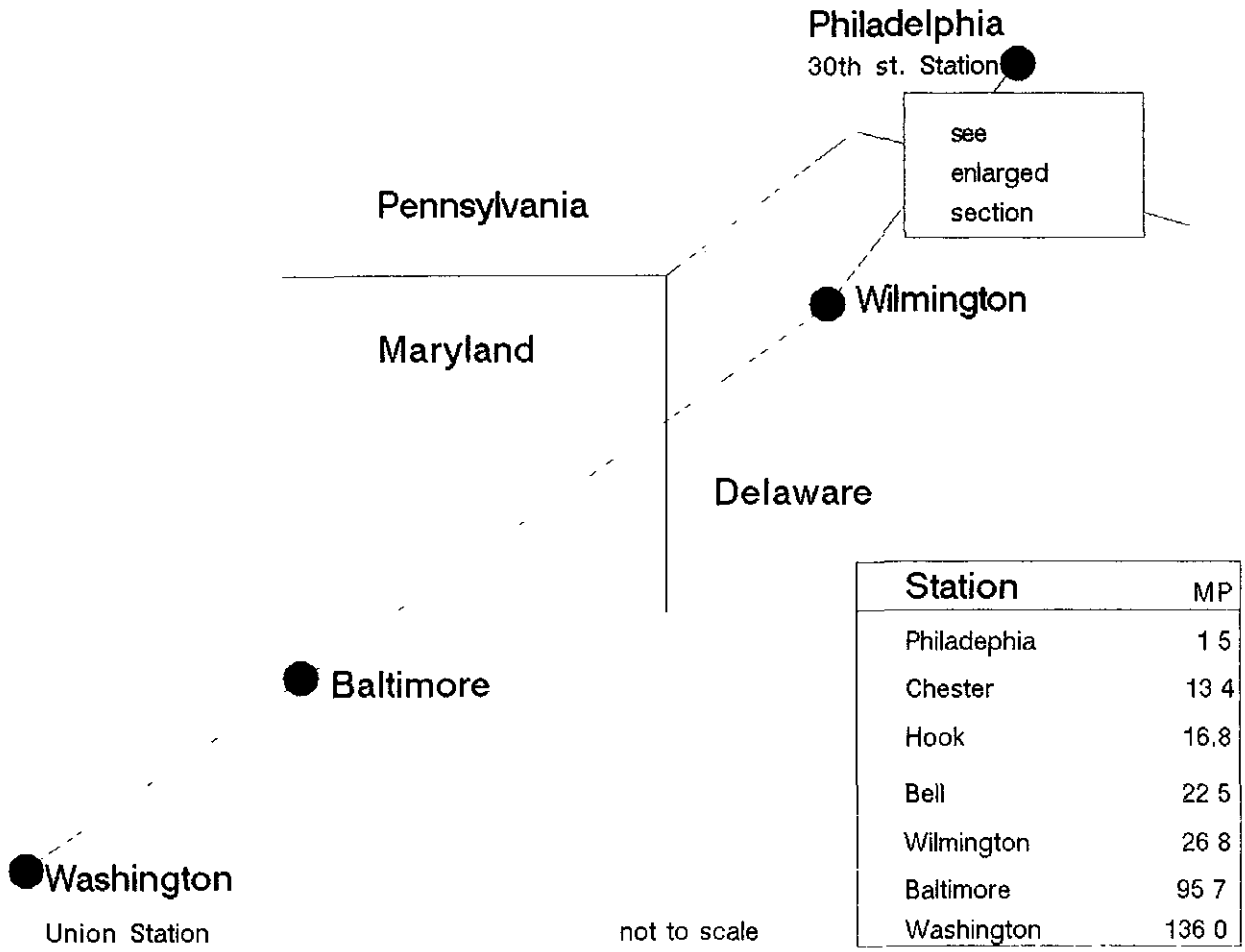
[1] The tower operators at Hook are assigned duty hours for the 1st shift, 7:30 a m. to 3:30 p.m ; 2nd shift, 3:30 p m to 11:30 p.m ; and the 3rd shift, 11:30 p m to 7:30 a.m.

[2] A mechanical device manually placed on a control lever which prevents the operation of the lever to another position without removing the device.

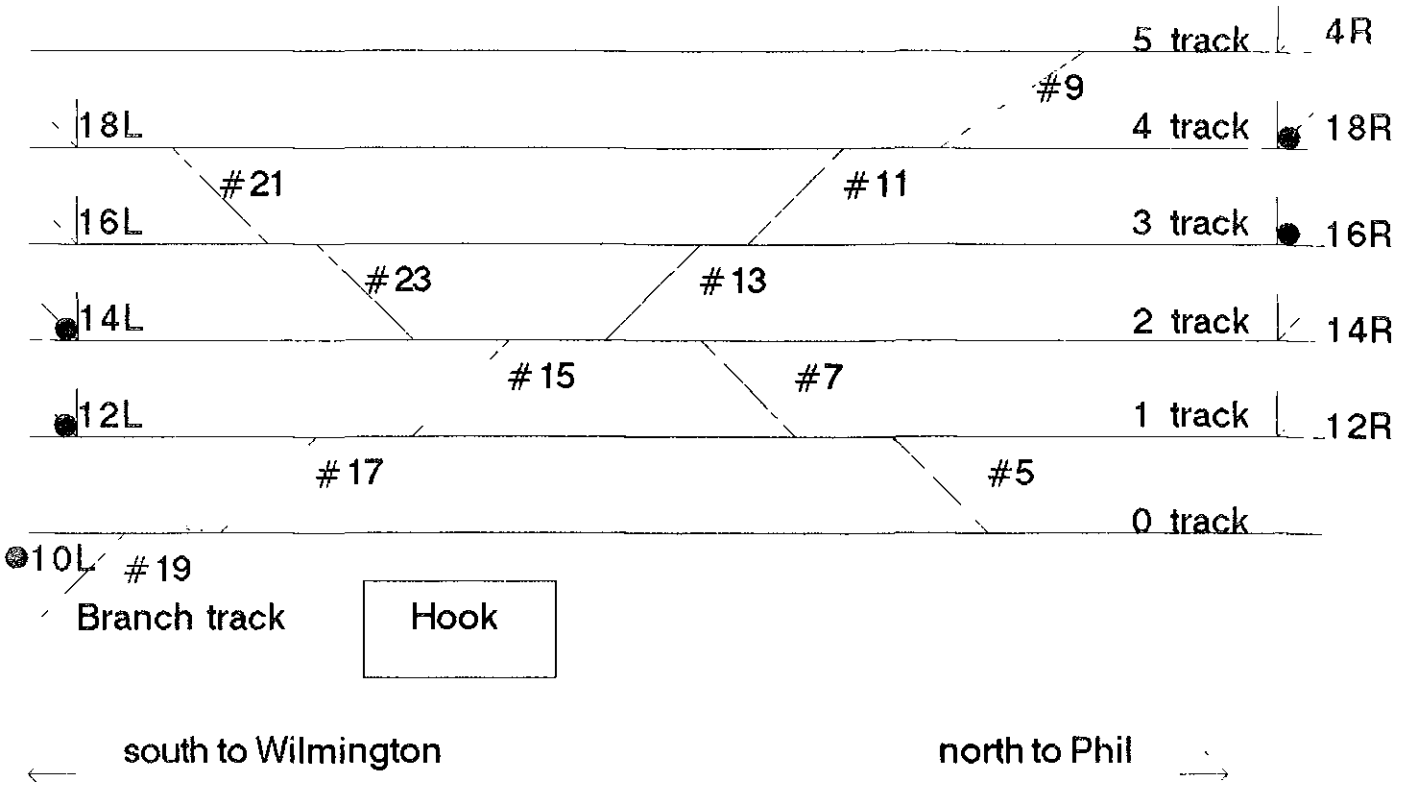
[3] The train dispatchers are assigned duty hours for the 1st shift, 8 a.m. to 4 p m.; 2nd shift, 4 p.m. to midnight; and 3rd shift, midnight to 8 a.m.





Station	MP
Philadephia	1 5
Chester	13 4
Hook	16.8
Bell	22 5
Wilmington	26 8
Baltimore	95 7
Washington	136 0

Figure 1.--Location of accident, Chester Pennsylvania



Signal for current of traffic

Signal against the current of traffic

not to scale

Figure 2 --Interlocking, signals, and crossovers

At 11:32 p m., SEPTA local train 9264, which was south of the Hook interlocking,[6] traveled north through the interlocking on track 1. Shortly afterward, SEPTA local train 0265 approached the Hook interlocking from the north on track 4. Train 0265 was to be crossed over to track 1 at Hook interlocking. The tower operator removed the blocking device from the lever that operates switch 15 and tried to reverse[7] the switch but was unable to do so. The tower operator reported it to the second-shift train dispatcher, who instructed the operator to bring SEPTA local 0265 south of the interlocking on track 4 and then to "work him off" the track (to reverse the movement of the train and use switches 21, 23, and 7 to track 1). The train dispatcher further instructed the tower operator to delay the action on train 0265 until Amtrak train 66, which was en route from Washington, D.C., to Boston, Massachusetts, passed the tower.

A Hook tower operator is required to begin a new block record sheet at 12:01 a.m. The third-shift tower operator stated that he was too busy to begin preparing and filling out the new sheet. The third-shift train dispatcher, who came on duty at midnight, did not verify with the tower operator that he was in possession of train order 920 as required by the operating rules. At 12:08 a.m., the track foreman in the Hook tower radioed the equipment operator and the track foreman with the ballast regulator to return to Hook tower so that they and the ballast regulator could be used on track 3. The crossing over from track 2 to 3 could only take place at the crossovers within the Hook interlocking. The crew with the ballast regulator heard and understood the message on their radio, but when the they attempted to confirm the transmission,they were unable to raise anyone on their radio. They then began to return, against the current of traffic, to Hook Tower southbound on track 2. The equipment operator of the ballast regulator stated that a yellow revolving light mounted on top the cab was illuminated; the headlights and red marker lights at the rear also were illuminated. He further stated that the plow was in the up position, the normal position for travel.

At 12:15 a.m., the third-shift tower operator began to enter information on the block record sheet; he entered the information from the train order taking track 2 out-of-service, but he did not enter the information about the BDA as required by the operating rules. At the same time the tower operator, a

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[6] 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.

[7] The normal position of a switch is for straight movement on the track, and the reverse position is for movement away from the track to another track.

general track foreman, and a track foreman were in the tower discussing moving the ballast regulator from track 2 to track 3, annulling train order 920, returning track 2 to service, and taking track 3 out-of-service so they could begin work on track 3. However, the tower operator stated that these actions could not be accomplished until after train 66 passed through the interlocking. At 12:20 a.m; a signal maintainer arrived at Hook tower to remove switch heaters or any other equipment on track 3 that could be damaged as a result of the intended track work. The tower operator reported to the signal maintainer that he had been unable to reverse the 15 switch and the circumstances of the switch failure.

The Accident

The third-shift tower operator at Hook stated that the Bell tower operator had reported over the block line that train 66 passed Bell tower at 12:27 a.m.; the running time for an Amtrak train from Bell tower to Hook tower normally is about 4 minutes. The third-shift tower operator also said that when Bell reports a train going by he has 2 minutes to decide how to handle the train. The tower operator also stated that, without permission from the train dispatcher, he removed the blocking device from the 14L signal lever and operated the lever causing the 14L signal to display a clear indication. The tower operator further stated that he did not operate the lever to reverse the 7 crossover switch. Track 2 through the interlocking remained in the normal/straight position. At 12:31 a.m., train 66 passed the Hook tower. The tower operator stated that train 66 did not slow as if to crossover (the speed would have been 40 mph); he also said he was busy talking to the individuals in the tower and did not realize anything was wrong.

The engineer of train 66 stated that he was operating the train by Hook tower on a clear signal at the authorized speed of 90 mph. He also stated that he saw no one around or in the tower as his train passed. However, he further stated that the bright lights in the interlocking made it a bit more difficult to see. The engineer said that he continued to operate the train at 90 mph by Hook tower, through the interlocking, and continuing on track 2. The engineer stated that about 1/2 mile north of Hook tower he saw two lights that he thought were on an adjacent track. He estimated that when he was approximately 900 feet from the lights he determined that the lights belonged to equipment on the same track and he immediately applied the train brakes in emergency because a collision appeared to be imminent. He then left the engineer's seat on the right side of the locomotive cab and crossed over to the opposite side of the operating cab intending to go into the machine room.

Meanwhile, the equipment operator and track foreman on the ballast regulator saw the headlight of a train approaching. When they became aware it was on the same track and closing at high speed, the equipment operator stopped the regulator and he and the track foreman jumped off. The ballast regulator speed had been about 15 mph and it stopped at the south end of the Highland Avenue station.

Shortly afterward the train collided with the ballast regulator at the south end of the Highland Avenue station. The equipment operator and the track foreman had run away from the ballast regulator and the track and were standing outside the track structure when the collision occurred; they were not injured. The ballast regulator raised up at impact and struck both sides of the windshield of the lead locomotive. The engineer was standing behind the fireman's seat when the ballast regulator broke both sides of the windshield inward. As the train continued to move forward, it carried the ballast regulator on its front end until the ballast regulator struck a bridge girder and derailed the train. Train 66 then passed through several bridges and the lead locomotive unit turned 180° and fell over the embankment. The second locomotive unit turned on its left side and wedged between the two girders of a bridge. The engineer, who was seriously injured, was ejected through the open windshield of the lead locomotive and came to rest approximately 25 feet in front of it at the bottom of the embankment. The lead locomotive came to rest on its left side.

Following the accident, the conductor, who was not injured, organized the on-board train crewmembers in the cafe car and arranged for protection of the train and the evacuation of the passengers. He also began to transmit emergency messages on his handheld radio. The third-shift tower operator said he became aware of the accident when he heard the emergency call from the conductor of train 66. The third-shift tower operator stated he immediately picked up his briefcase and left the tower. The general track foreman had left the tower just as train 66 passed the tower and was talking to one of the maintenance-of-way workers when one of the track foremen in the tower came to the top of the stairs and shouted to him that an accident had occurred. At the same time, the third-shift tower operator came running down the steps. As he passed the general foreman, the general foreman asked the third-shift tower operator where he was going, the tower operator replied that he had to take care of something. The general foreman was joined by the track foreman and told that train 66 had been seen down track 2 and had hit the track equipment. The track foreman went to the accident site and the general foreman returned to the tower. The signal maintainer was at the operator's desk attempting to make radio contact with individuals at the accident site.

The third-shift tower operator stated that he drove his automobile to the accident site. He said that after he saw the severity of the accident, he panicked and left the accident site. He also stated that he realized he would need an attorney when he left the accident site. The tower operator did not talk to anyone at the accident site, and none of the persons at the scene could recall seeing him there when they were questioned by investigators. The third-shift train dispatcher was unable to contact anyone at Hook tower to determine what had happened until the signal maintainer contacted him. The signal maintainer recorded the position of all signal and switch levers on the instructions of the train dispatcher and his supervisor. The signal maintainer applied blocking devices to protect the area of the accident on the instructions of the train dispatcher. Amtrak Rule 914 requires that operators remain on duty until relieved. (See appendix F.)

Injuries to Persons

	Train Crewmembers	On-Board Service Personnel	Passengers	Total
Fatal	0	0	0	0
Serious	1	0	1	2
Minor	8*	0	15	23
None	0	4	114**	118
Total	9	4	130	143

* Includes three crewmembers deadheading
** Estimates provided by Amtrak

See appendix D.

Train Information

Amtrak passenger train 66 (the Night Owl) departed Washington, D.C., at 10:20 p.m. for a northbound trip to Boston, Massachusetts. The train consisted of two locomotive units, two baggage cars, four coach cars, one cafe car, and three sleepers.

Locomotive Units.--The General Motors (GM)/ASEA model AEM-7 electric locomotive units were operated in multiple by electric current collected by a pantograph from the catenary at a nominal 11,000 volts a.c. and transformed and rectified into low-voltage direct current for the traction motors. Each unit, rated at 7,000 diesel equivalent horsepower, had 51-inch-diameter wheels and weighed 201,400 pounds.

Each locomotive unit was equipped with overspeed control, type F couplers, anticlimbers on the end sills, Vapor Corporation electronic alerter control, Union Switch and Signal schedule 384

automatic cab signal and train speed control system, dynamic braking, and schedule 26-LIC air brake system with pressure maintaining feature. Each unit also was equipped with speed cruise control with speed selection from 12.5 to 125 mph.

The AEM-7 locomotive is double-ended with an identical operating cab (including equipment) at each end. Each cab was equipped with laminated triplex polycarbonate windshields which extend nearly the full width of the forward cab end bulkheads and are separated by collision posts. Access to the cabs is through hinged doors located on each side of the cabs; the cabs are connected by narrow passageway through hinged doors in the rear cab bulkheads. A floor-mounted swivel seat is located on each side of the cab, and a retractable jump seat is located in the rear bulkhead of each cab.

The engineer's seat is on the right side of the cab behind a flat-topped desk-type operating console (integrated control console). A controller with 10 motoring and 6 braking zones, a reverser, and radio handset are on the left side of the console top. The handles for the automatic and independent brake valves are on the right side of the console.

The lead locomotive unit was equipped with a magnetic cartridge multievent Pulse tape recording device, which is designed to record speed, time, distance, amperage, automatic and independent braking, and throttle position. The tape from the lead locomotive unit only recorded the speed, time, distance, direction of travel, and automatic braking function, the analog code for amperage and the binary code for throttle were not recorded because of an equipment malfunction. The second locomotive unit was equipped with an Aeroquip speed recorder which recorded speed and distance on a paper tape readout.

Coach Cars.--The four coach cars were of the Amfleet type built by the Budd company in 1977. The 85-foot-long cars were constructed of stainless steel, with vestibules at both ends and electrically powered sliding doors on both sides of the vestibules. Sliding end doors at each end of the car also were electrically powered.

Each 104,000-pound coach car had 84 floor-mounted transverse seats with high reclining backs arranged in pairs, 21 pairs on each side of a center aisle. The seats could be manually rotated 180°. The seats in two of the coaches were equipped with latches that prevented them from rotating; rotating the seats to the alternate position required a foot pedal to be depressed. The seats in the other two coaches were not equipped with the same kind of locking devices; they were locked into position by aligning and pushing the seat 3 inches toward the sidewall. These units unlock when they are pulled 3 inches inboard.

Food Service, Sleeper, and Baggage Cars.--The food service car, Amcafe, was built by the Budd company in 1977. The exterior of the car was the same as the coach car; however, the car interior had a passenger compartment with 23 standard seats of the same type as the coach car and a passenger compartment with 18 club chairs facing dining tables. The two passenger sections were separated by a pantry-counter area in the middle of the car.

The sleeper cars also were built by the Budd company in 1950. Each car was constructed of stainless steel and was 85 feet long. A vestibule with electrically powered sliding doors, one on each side of the car, was located at one end of each sleeping car. Also, an electrically powered end door was located at each end of the sleeper car. One-half of the sleeper car interior had 10 roomette-type sleeping rooms, 5 on each side; the other half of the car interior had 6 bedrooms.

Each of the two baggage cars were 70 feet long with two doors on each side to load and unload baggage. A door on the ends of each car allowed employees to enter and exit the car.

Ballast Regulator Information

The ballast regulator, a model BEB-17 ballast equalizer, was purchased new in 1980 from the Canron Rail group. Its maximum speed was 30 mph, and it weighed 33,160 pounds. It was 29 feet 10 inches long, 10 feet wide, and 10 feet high. The unit was equipped with a fixed radio for the train operations channel and the maintenance-of-way channel. A yellow revolving light was mounted on the roof of the cab; headlights and red marker lights were displayed front and rear. The headlights and red marker lights were interconnected so that the red marker lights were displayed at the rear when the headlights were on, facing the direction of travel.

The wheels and axles were insulated to prevent the ballast regulator from shunting[8] the rails and de-energizing the signal control circuits. The assistant vice-president-chief engineer (AVP-CE) of Amtrak stated that in 1977 the Amtrak engineering department decided to use insulated (nonshunting) maintenance-of-way equipment. Since then, only insulated equipment has been purchased for the Northeast Corridor Improvement Project (NECIP) program and for the maintenance function of the engineering department. Amtrak believes that track equipment that shunts

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[8] The wheels and axles on equipment designed to shunt a track circuit when it enters a track section create a low-resistance current path from one rail to the other within the section. When contacts open in the track circuits, as a result of a shunt, they indicate that a train is present on that section of track and open the single control circuits

must be considered unreliable for shunting the signal circuitry because it will not always shunt the circuit. Intermittent shunting of track circuits can occur on noninsulated rail mounted equipment when effective contact with the rail surface is interrupted. Several factors can prevent the eqiupment from making effective contact with the rail, such as rusty rail surfaces and operation of the equipment causing wheel lift or deposits of material on the rail. When the circuits are not shunted, the signal system will not reflect track occupancy. The AVP-CE stated that Amtrak did not want employees to rely on the equipment to provide signal protection.

During the investigation, Safety Board contacted several major on-track equipment suppliers (Tamper, Kershaw, Burro Cranes, Fairmont Railway Motors, and Modern Track Machinery) to determine if a device was available that could be installed on the ballast regulator to shunt the signal circuitry. The suppliers advised that were not aware of a device that could be installed on equipment to provide positive shunting. One supplier (Tamper) stated that it had a retrofit component assembly with metallic straps wired through a switch to the axle for a make-break type circuit on its own equipment, but that it would require modification for other suppliers equipment. The Tamper shunting device was first used by the Canadian National Railways and later by the Norfolk Southern Corporation. The AVP-CE stated that after the accident Amtrak changed its policy and will purchase all noninsulated equipment; present equipment will be modified to be noninsulated when it is shopped for overhaul.

Damage

Locomotive Units.--Major roof panels, including the pantograph were torn loose from the lead locomotive unit. The leading end had a large dented area with a large gouge in the body, a broken and missing windshield, and extensive superficial body damage on its left side. Extensive damage was sustained below the superstructure; both trucks and all appurtenances below the locomotive body were torn away from the car body.

The second locomotive unit, which was wedged between two bridge girders, received extensive damage to the trucks and traction motors and extensive surface damage to the left side and roof, including the pantographs.

Cars.--The first car behind the locomotive, a baggage car, came to rest at a 70^{0} angle to the track. It received extensive damage to the trucks, the undercarriage, the coupler, and the draft gear. The coupler was twisted but remained coupled to the next car, also a baggage car. The second car also had coupler and draft gear damage and moderate truck and wheel damage as a result of derailing; the car remained upright.

The first coach car which jackknifed, blocking two tracks, was extensively damaged on both ends. It had extensive damage below the superstructure.

The second coach car had extensive coupler and draft gear damage. The vestibule at each end of the car had light damage.

The third coach car derailed and struck and rode up onto a bridge girder. The car received extensive damage to the undercarriage, trucks, wheel, end, coupler and draft gear; the car remained upright. The fourth coach car also rode up onto the bridge girder and received similar damages as the car ahead. The remaining cars received light damage to the trucks, wheels, and the vestibule areas as a result of the derailment.

Other Damage

Approximately 250 lineal feet of track 1 was damaged; tracks 2 and 3 each had approximately 960 lineal feet of damage.

Structural damage to the first bridge was limited to minor steel damage but the timber bridge deck was substantially damaged. The second bridge received substantial damage to the floor system, knee braces, and both girders between tracks 1 and 3. The girders supported track 2 and 1/2 the adjacent tracks 1 and 3.

The ballast regulator was destroyed. The communications and signal equipment and the electrical transmission system had minimal damage.

Damage was estimated by Amtrak as follows:

Equipment	$2,999,000
Track and Structures	398,215
Total	$3,397,215

Personnel Information

Train Crew.--The crew of train 66 consisted of the engineer, the conductor, four assistant conductors, and four service personnel. All the crewmembers were qualified for their assignments by Amtrak. Each of the operating crewmembers had successfully passed Amtrak's operating rules examination and a physical examination and had qualified on the physical characteristics of the railroad.

The engineer had been operating locomotives for 9 years following a 6-month engineer training program. At the time of the accident, he had been operating Amtrak passenger trains for the last 3 years. Before that, he operated Consolidated Rail Corporation (CONRAIL) freight trains and SEPTA commuter trains.

He had a physical examination within the past year; he had no medical problems and was not required to wear glasses.

The engineer had reported for a previous assignment at 11:30 p.m. on January 27, and had gone off duty at 7:30 a.m., on January 28. Between 1:30 p.m. and 2 p.m. on the same day, he was called to report for duty at 5:30 p.m. He reported for duty at Penn station in New York, New York, on time, departing at 6 p.m., and arrived at Washington D.C., at 8:55 p.m. At 9:50 p.m., he reported aboard train 66 and departed Washington, D.C. at 10:20 p.m. for New York. He was not regularly assigned to train 66, but was operating the train from Washington, D.C., to New York, as an extra assignment.

The conductor had worked as a conductor on trains operating on the Northeast Corridor for 23 years. He had reported for duty at 5 p.m. to Penn station in New York. He departed at 5:30 p.m. for Washington, D.C., on a different train than the engineer, arriving at 9 p.m. He reported for train 66 and departed Washington, for New York at 10:20 p.m.

Track Crew.--The equipment operator of the on-track equipment had been qualified in the operating rules by Amtrak and had been working for Amtrak for 10 years. He had worked as a trackman, foreman, and engineer work equipment. The equipment operator worked 8 p.m. to 6 a.m., 4 days a week.

The track foreman had been qualified in the operating rules by Amtrak and had been working for Amtrak 11 years. He had worked as a trackman, machine operator, and foreman. He also worked 8 p.m. to 6 a.m., 4 days a week.

Third-Shift Hook Tower Operator.--The tower operator had successfully completed the operator training program on August 28, 1980, and had been working as a tower operator since then. However, the operator was on sick leave for a 13-month period following an automobile accident. He stated that the training he received consisted of 4 to 6 weeks of classroom training on the movement of trains, safety, and rules, and that he finished second in the 20-member class with a score of 95. He was then sent to Media tower to learn the tower operation. After spending about 6 weeks of "posting"[9] on the job, the regular tower operator notified the supervisor that he was ready to be qualified for the Media tower. The tower operator was last examined on the operating rules on October 28, 1987.

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[9]On-the-job training consisting initially of watching an on-duty tower operator perform his duties at the location. Eventually the trainee performs the functions of the job under the supervision of the on-duty tower operator.

Amtrak personnel records indicated that the third-shift tower operator was qualified to operate three towers: Paoli, Thorn, and Park. Hook tower was not listed as one of the towers he was qualified to work. However, his name did appear on the list that were used by Amtrak scheduling clerks for assigning extra operators to duty. Further, personnel records indicated that the operator had posted at Hook tower in 1987 when he was assigned to work at another location. On October 2, 1987, he again posted at Hook tower because he had not worked at Hook for 5 months; in 1987, he posted a total of 14 days and worked unsupervised for 13 days. Although he had posted on all three shifts at the Hook tower, he had not worked the third shift alone in the year preceding the accident. He had worked one first shift at Hook tower in January 1988 before the night of the accident.

The operator was not regularly assigned at Hook tower but worked as an extra tower operator filling vacancies occurring in any of the towers he was qualified to work. Extra operators work on an "as needed basis." Extra operators are called on a "first in/first out" schedule and can be called to work any shift. The operator said he preferred to work at Media tower because it was less complex and traffic was slower than at Hook tower. He further stated that Hook tower was less desirable because of the high speed of the trains and the local trains that were crossed over between the high-speed trains.

On January 28, 1988, the day of the accident, the operator had just returned to duty following a 1-week vacation. He stated that during his vacation he would normally arise about 9 a.m. and retire about midnight. On his first day back to work, he got up as normal. He stated that during the day, he had anticipated a call from the Amtrak scheduling clerk assigning him to work a shift. When the call had not been received, he called the scheduling clerk at 8:30 p.m. and was assigned to work the third shift at Hook tower. He said that he attempted to rest after the call but that he did not sleep before reporting for work.

Before his employment with Amtrak, the tower operator had attended Pennsylvania State University for 3 years, majoring in recreational parks administration. He explained that he left school after 3 years because the courses had gotten more difficult and because he was more interested in employment than in continuing at college. He stated that he had also played drums in a rock band and continued to sit in (play) with a local group for recreation whenever possible.

Amtrak records for efficiency checks from October 1, 1980, to October 14, 1985, indicated that 11 efficiency checks had been performed on the tower operator. Eight checks were the result of his missing calls for work assignments. Three tests were observed on the operator's performance, responsibilities, and tasks in tower operation; the total recorded time for the

observations of the operator during the three checks conducted on performance was 9 minutes. The operator had returned to work on January 14, 1987, after being on continuous sick leave from November 4, 1985, reportedly as a result of an automobile accident; he had received permission from his doctor on December 22, 1986, to return to work. Amtrak management advised the Safety Board that the operator had received an efficiency check relating to performance in November 1987. Repeated requests were made by the Safety Board for a copy of the November 1987 efficiency check, but Amtrak has not furnished the record.

The operator's discipline record included four disciplinary letters, three suspensions (15, 30, and 45 days), and two dismissals from employment. A representative of Amtrak said that the suspensions were not executed because the operator's excessive absenteeism did not permit Amtrak to schedule the days for the suspensions. These discipline incidents resulted from the operator's numerous failures to be available for work, failures to respond to calls for work, and failure to report for work when he had been assigned. He was returned to service on appeal with a conditional probationary period from January 9, 1987, to January 9, 1988. Conditions for continued employment during the probationary period required that there be no occurrences of similar violations of carrier rules under penalty of dismissal without further appeal. The operator's 1987 work record revealed that he was on sick leave for 85 days, 77 of which were continuous, from June to September. Also, he was absent because of reported car trouble for 7 days, compassionate[10] leave for 3 days, and 14 missed calls beginning May 29. In addition, the operator's personnel file contained copies of three letters sent to the operator by the division operator after the operator returned to duty at the end of 1987. These letters related to the operator's absences and missed calls warning him to correct the problem.

An Amtrak officer testified that there was a shortage of tower operators. He stated that "we attempt to qualify extra people at as many towers as possible. With the lack of additional block operators, that has been curtailed somewhat, which is why we're getting additional block operators."

The operator stated that when he returned to work after his sick leave he sought to be transferred to another type of job. He was concerned about the pressure of working in towers and the extra operator status that required he work on the "first-in, first-out" schedule.

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[10] Leave granted because of death in the immediate family; the tower operator's father died

Track Information

The authorized timetable speed for passenger trains is 90 mph north of Hook interlocking to the next interlocking at Baldwin. Hook interlocking is located at milepost 16.8; Baldwin interlocking is located 5.1 miles north at milepost 11.7. The track in the area of the accident was 140 RE continuous-welded rail (CWR) on treated 7 inch by 9 inch by 8 foot 6 inch wood crossties with 7 3/4 by 14 3/4 inch double shoulder tie plates with two rail holding spikes and one plate holding spike per plate. Rail anchors were applied to every other crosstie with a tight fit and additional rail anchors were applied to every tie approximately 200 feet north and south of bridge approaches. The ballast was crushed stone with an approximate depth of 18 inches below the bottom of ties.

The track gradient northward from Hook interlocking is 0.24 percent descending to milepost (mp) 15 then ascending at 0.28 percent to mp 14.5. The alignment from Hook interlocking to the point of collision is as follows:

Hook interlocking to mp 16.45.... straight
mp 16.45 to mp 16.4..... 0^{0} 10'curve left
mp 16.4 to mp 15.92..... straight
mp 15.92 to mp 15.87..... 0^{0} 10'curve right
mp 15.87 to mp 14.89..... straight
mp 14.89 to mp 14.79..... 0^{0} 30'curve left
mp 14.79 to mp 14.5..... straight

Two street bridges are located in the area of the accident. Each bridge carries four railroad tracks over a span of approximately 68 feet. The bridges, built in 1903 by the American Bridge Company, are open deck thru girder[11] type.

All tracks between Hook and Baldwin interlockings met or exceeded the minimum requirements for class 5 track.[12] The daily track inspection reports for the 30 days before the accident indicated no defects had been found.

Hook interlocking is controlled by an operator located on the upper level of a two-story building on the east side of the interlocking. The operator's room is 15 feet 1 inch by 15 feet 4 inches. It contains a desk and chair for the operator's use; several defect recorders; a power control board; a restroom; and,

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[11] "Thru girder" describes bridges where trains pass between the girders which project approximately 36 inches above the top of the rail.

[12] Federal Railroad Administration Track Safety Standards (49 CFR 213).

in the middle of the room, a Union Switch and Signal Company model 14-type, A-5, 23-lever interlocking machine that measures 7 feet 10 inches by 4 feet 7 inches. The signals are controlled by the operator activating a lever on the interlocking machine which energizes the circuit, allowing the signal to display an indication in accordance with track occupancy. The position of switches are changed when the operator turns a lever on the interlocking machine that unlocks the switch, operates it to the called for position, locks the switch in position, and, at appropriate times in the operation, opens and shunts signal indication circuits.

Northward home signal 14L governs the northward train movements on track 2. It displays a stop indication until the operator at Hook interlocking activates the 14L signal lever, and the signal then displays an indication in accordance with track occupancy.

Following the accident, the 15 switch was not found in the reverse and lock position; graphite was applied and the switch worked as designed. The second-shift tower operator stated that the mechanism for switch 15 was difficult to operate but if the third-shift tower operator had continued to attempt to reverse the switch he probably would have succeeded in reversing it. The second-shift operator said that he was aware that the switch was difficult to operate because of his years of experience at Hook and that the third-shift operator may not have known of the difficulty because of his lesser experience at the tower. Tests of the signal and track switch systems found no defects in either system, and all functioned as designed.

Method of Operation

The 23.9 miles of main line track of the Washington, D.C., to Philadelphia line from Penn interlocking at Philadelphia to Landlith interlocking near Wilmington is designated as section "D." It is controlled by a train dispatcher located in Amtrak's Philadelphia 30th Street station. The track is part of Amtrak's Philadelphia division and is used by intercity passenger trains traveling between Washington, D.C., and Philadelphia by commuter trains operated by SEPTA and freight trains operated by Conrail.

Trains are operated over the territory by an automatic block signal system (ABS), a manual block signal system (MBS) for movements against the current of traffic, an automatic block position light signal system, and cab signals. The interlocking

at Phil is controlled by a train director[13] at Penn; at Baldwin by an operator at Baldwin when it is open[14] (part-time block station); at Hook by the operator at Hook; and at Holly and Bell by the operator at Bell. Interlocking rules are in effect at all the block stations. Timetable directions are south to Washington and north to Philadelphia.

Between Phil and Hook, a distance of 13.2 miles, four main tracks are designated from the east as 1, 2, 3, and 4. All tracks are signalled for movement with the current of traffic; 1 and 2 north, 3 and 4 south. Cab signal rules are in effect for trains operating with the current of traffic on all tracks.

In 1978, Amtrak initiated a procedure to deactivate a track circuit by removing a fuse to provide protection for maintenance-of-way equipment that did not shunt track circuits. The fuse could only be removed by a communications and signal department (C&S) employee. Removal of the fuse prevented tower operators from providing signals allowing a train to enter the out-of-service area. Amtrak officials stated that the procedure for pulling fuses was discontinued in 1981 when Amtrak decided to conduct track maintenance work at nights because there was much less train traffic and there would be less interference with the track work projects. C&S employees were assigned to a program to reconstruct the signal system on the corridor. Amtrak officials stated they depended on the operating rules to provide the protection for the nonshunting equipment.

Amtrak's engineering department provided track barricades to be used as physical barriers to define the work limits of a track out-of-service for track work. (See appendix E.) Instructions require that track barricades be placed on the track and locked after permission to occupy the track is received; barricades are to be removed before the track is cleared. The instructions stated that one track barricade would be placed at each end of the work limits and that if properly applied, track barricades will shunt the track circuit; however, they should not be relied upon to provide a positive shunt. The barricade is not capable of stopping a train or other equipment; its purpose is to shunt the track circuit. The metal barricade is attached to the head of the rail so that it cannot be lifted off. Brass button

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[13] A train director is a supervisory interlocking operator, who is employed at large complex interlockings and who has authority within the limits of the interlocking to move trains without first receiviny train dispatcher permission

[14] When Baldwin station is closed the switches are left for normal/straight movement through the interlocking and crossover movements can not be made at that station during those closed hours.

head rivets on the ends of the barricade make a contact with rail surface for shunting the track circuit. An interoffice memo date January 28, 1985, to all division engineers from the top engineering officer instructed them to order the number of barricades needed for the production and maintenance gangs using on-track equipment and to initiate the use of the barricades as soon as they were received. The memo also stated that Amtrak rules committee approved the use of metal barricades where tracks are taken out-of-service for maintenance-of-way equipment. The memo further stated:

> The protection afforded by the use of these metal barricades will be in addition to that provided by the standard train order blocking device requirements ... if applied properly, these barricades will shunt the track circuit, however, you must not depend on such a shunt as protection...

The engineering officer testified that the "... track barricade is another backup safety item to back up the operating rules ... it has been effective if used properly ... it works." Although Amtrak's engineering practice document outlined the procedure for the use of barricades, the track foreman testified that he did not know he had the authority to order barricades to be installed, and that he had not seen the document. The track foreman in charge of the maintenance persons involved in the work on track 2 testified he had never used track barricades before the accident. One track foreman testified that because of insufficient track barricades at his headquarters, he had to make his own shunting devices out of rail clamps and welding cables.

Even though track 2 was out-of-service between Hook and Phil interlockings, both track foremen involved with the ballast regulator stated that barricades were not required to protect the ballast regulator because the equipment was moving and barricades were not called for in train order 920 which took the track out-of-service. (See appendix C.) Amtrak officers testified that the maintenance-of-way employees did not need a train order specifying their use to use track barricades, but that it was up to them if they applied them or not. The general track foreman who had been assigned to perform work within Hook interlocking testified that had he been foreman in charge of the out-of-service track he would have installed a barricade at the north end of the out-of-service track and another barricade at the north end of Hook interlocking on the out-of-service track.

Operating Rule 829 provides protection for on-track maintenance equipment. (See appendix F.) The rule provides that a train order will be issued and addressed to the foreman who requests the use of the track. It requires that the operator must first apply blocking devices to all switch and signal levers

leading to the affected track and confirm to the train dispatcher that he has done so before a train order can be issued. Information regarding the blocking devices must be entered by the operator in red ink on the operator's block sheet. If it is necessary for the operator to remove a blocking device, he must secure permission from the train dispatcher before doing so and, immediately following the movement, the operator must re-apply the blocking device and advise the train dispatcher. The train dispatcher or operator must not permit additional equipment to enter the out-of-service limits unless authorized by the foreman named in the train order. Rule 829 also provides that "Signal must not be displayed for movement in the portion of track taken out-of-service."

Neither the second- or third-shift operators at Hook tower had reversed the 7 switch or blocked it for the out-of-service portion of track 2. The 7 switch is the last switch that can be used to cross trains from track 2 before the out-of-service area. Rule 829 states that all switch and signal levers leading to the affected route must have approved blocking devices applied. Amtrak's director-operating rules/procedures (DOR/P) stated that the 7 switch would not be required to be blocked because it leads away from track 2 and, therefore, switches 15 and 23 would be blocked in the normal position to protect entrance to track 2. He further stated that to use track 1 straight through the interlocking, the 7 switch would have to be normal and that four movements between 10:06 p.m. and 12:30 a.m. were made before the accident that would require BDR and BDA applications for the 7 switch. Amtrak's DOR/P further stated "that would mean more work for the operator, train dispatcher and more manipulation of the switch. That 7 switch in and of itself is enough blocking because if it's reversed, nothing will go up track 2. So in that case you wouldn't need a block on 14 signal, 23 switch or any other, 7 switch would be sufficient." The DOR/P said that Amtrak is a member of the Northeastern Operating Rules Advisory Committee (NORAC) which is considering a change in the present operating rule to require an operator, when there is an out-of-service portion of track, to line the route for the train and then request permission of the train dispatcher to BDR the signal lever.

Operating rule 913 outlines the duties of train dispatcher and states that the train dispatcher must insure that the blocking devices afford the necessary protection. Train dispatchers are required to report any violation of the operating rules; they also must upon assuming duty, verify with the affected operator that they are in possession of all train orders. (See appendix F.) However, the second- and third-shift train dispatchers stated that this procedure was not followed and that they would wait for the operator to report to him at some time during the tour of duty, when time permitted, and verify the orders in effect. The third-shift train dispatcher further

stated that following the accident, Amtrak provided train dispatchers with a stamp to stamp the train order book and go through the list with all the operators and ask them what orders they had in effect. When asked if the new practice interfered with or delayed the movement of trains because of the requirement for the verification of train orders or if it added significantly to the dispatcher's workload, he responded that it did neither.

Operating rule 914 applies to the duties of operators. The rule states that operators must obey the instructions of the train dispatcher or train director and that they are responsible to deliver train orders to persons addressed. Operators also are required to observe trains as they pass their location and are not to remove blocking devices that have been ordered applied by the train dispatcher unless authorized by the train dispatcher. The rule further prohibits operators from leaving their duty station until relieved. Also, the operator must complete the transfer portion of the station record of train movements and the relieving operator must read the information aloud to the operator being relieved and must also contact the train dispatcher and verify that they are in possession of all train orders.

The DOR/P stated that Amtrak does not use train orders to notify engineers and conductors of trains when tracks are taken out-of-service because train orders are not an effective or efficient method and their use would cause more confusion and more chance of error to issue such orders.

Amtrak representatives stated that the safety department has a defined role within the corporate structure that centers on the personal welfare of the employees in the work place, the environment of the work place, and the tools that are used, but that its role is not an operational role. Amtrak's manager of safety and environment testified that the safety department did not monitor operating employee performance, and that safety department personnel rode trains to observe the right of way and performance of work gangs but not to observe the performance of the train crewmembers for safety. He further stated they do not evaluate the performance of dispatchers and operators and have no inputs into the operating rules and procedures of the operating department. Asked if the safety department made any risk analysis on procedures used to protect the out-of-service tracks and engineering employees or of track barricades and their effectiveness, the manager of safety advised that they did not because that was an operating area. The manager of safety also stated that the safety department had never analyzed the safety of the shunting or nonshunting of equipment or made any recommendations on shunting or nonshunting of equipment.

Following the accident, Amtrak issued a notice, dated February 8, 1988, to all train directors, assistants, lever persons, and block operators regarding distractions in towers. The notice outlined problems that arise in towers with individuals causing distraction that Amtrak considered unacceptable. It further outlined the responsibility of the operator and the procedures to be followed to eliminate distractions by individuals in the tower.

On the portion of tracks between Washington, D.C., and Wilmington, Delaware, Amtrak uses a centralized electrification and traffic control (CETC) system to control train movements. The CETC system uses computers to assist the train dispatchers, from a centralized control center in Philadelphia, to control the signals and switches remotely. The CETC system has eliminated the need for tower operators and the need for communication and coordination by the dispatcher, but allows the dispatcher to arrange routes, setting signals, and aligning switches from the control center. Assisting the dispatcher at the control center is a projected CRT visual display of the tracks including the location of trains. Various colors on the display indicate the occupancy of track sections, including the color blue to indicate a track that is out of service. The CETC system does not indicate on the display equipment that is not shunting the signal circuitry.

Meteorological Information

The 0050 weather as reported by the Philadelphia, Pennsylvania, airport, approximately 5 miles north of the accident site, was clouds--clear; visibility--15 miles, temperature--17^{0} F., and wind--290^{0} at 5 knots.

Toxicological Testing

Urine and blood samples were obtained from the Amtrak engineer, the conductor, four assistant conductors, the train dispatcher, and a signal maintainer after the accident. The engineer, the conductor, three of the assistant conductors, the train dispatcher, and the signal maintainer all tested negative for drugs and alcohol. The fourth assistant conductor's blood and urine sample contained a marijuana carboxylic acid metabolite concentration of 27 ng/ml; the sample had been collected at 0728 on January 29, 1988. Samples were taken from the train crewmembers, except for the engineer, at the Sacred Heart General Hospital in Chester. The engineer was hospitalized at the Crozer Chester Medical Center, where samples were obtained. Samples from the dispatcher, the signal maintainer, and the tower operator were taken at the Hahnemaun University Hospital in Philadelphia.

Urine and blood were obtained from the tower operator about 4 p.m. on February 1, 1988. The operator left his duty station following the accident and could not be located for 3 days, at which time, he voluntarily agreed to provide blood and urine samples. The time delay in providing the samples was approximately 88 hours after the accident. The tests results indicated that the blood sample contained a marijuana carboxylic acid metabolite concentration of 8 ng/ml and the urine sample contained a concentration of 89 ng/ml. The urine sample also showed a concentration of cocaine metabolite (benzoylecgonine) of 0.081 ng/ml, a methamphetamine concentration of 74 ng/ml and an amphetamine concentration of 48 ng/ml.

Survival Aspects

The lead locomotive unit was lying at the bottom of an embankment on its left side. Both windshield halves had been knocked out during the accident. The upper rear corner of the right side window (next to the engineer's operating position) was displaced inward about 6 inches and the glazing material on the lower rear corner of the same window had been displaced inward about 4 inches. The engineer's seat was missing from the pedestal on which it had been mounted; the pedestal was undamaged. The bottom hinge of the access door to the electrical compartment door behind the engineer's station was jammed in a partial open position and could not be further closed or opened. There was no major crushing to the operating cab and the ballast regulator did not penetrate beyond the windshield. When the locomotive derailed, rotated, and fell over the embankment, the engineer was thrown about the cab before being ejected. He sustained a nondisplaced fracture of the left fibula, laceration, and abrasions. He was admitted to a hospital for 24 hours.

The passengers and crewmembers located in the passenger cars had no warning of the impending impact before the emergency application of the train brakes. The passengers described a series of jolts that followed the emergency brake application and explained how they were thrown forward into the seat or structure in front of them or onto the floor. Two passengers received injuries when luggage, ejected from the overhead luggage racks, struck them.

The first coach car had all seat units on both sides of the aisle facing toward the windows at angle from forward of 30^{o} to 40^{o}. Eleven seat cushions were on the floor of the car. The top of the seat cushions at seat locations 64 and 74 were dislodged from the seatback frames and the sheet metal support was exposed. The window at seat 73 had small cracks in the surface.

Twelve seat units were facing outward toward the windows about 30^{0} to 40^{0} on the second coach car. Evidence on the seat cushions of seats 75/76 indicated that a passenger had been injured at this location. An air vaporizer (odor/fume controllant) is located in each end of the cars; the assembly consists of a sheet metal housing and a cartridge holder. The cover of the unit, which also was constructed of sheet metal, measured 7 by 22 inches and was secured in place by two latches and a cable. The cartridge holder contained a gel cartridge and measured approximately 7 by 22 inches. The gel cartridge and holder for the vaporizer was on the floor between seats 9/10 and 13/14 and the cover was lying on seat 13.

The seat locking mechanisms were damaged and inoperable on the third coach car at seats 17/18, 27/28, and 75/76. The window between seats 75/76 and 79/80 was cracked. All other passenger cars were only slightly damaged or not damaged.

One passenger was hospitalized for 7 days for a contusion of the left shoulder, cervical sprain, and contusion of both knees. Eight on-board crewmembers and 15 passengers were treated and released for head trauma, strains, and sprains.

Amtrak testified at the Safety Board's public hearing on this accident that it had purchased 11,000 redesigned locking devices that would prevent seat rotation in an accident. At the time of the accident, none of the seats was equipped with the redesigned devices; Amtrak stated that delivery of these new locks had not been made at the time of the accident. The schedule for the completion of seat rotation locks is the end of 1989.

Also, at the time of the accident, Amtrak was equipping passenger seats in Amtrak cars with a plastic extruded radius strip to prevent passengers being hurt or cut by sharp edges when they impact the seat at the time of secondary impact. At the time of this accident, 6,000 seats had been equipped with the plastic strips and 150,000 seats had yet to receive the modification. The schedule for completion of the plastic extruded radius strips is also the end of 1989.

Further, Amtrak is equipping the vertical opening of the luggage racks on coach cars with a device to retain the baggage in the luggage area. At the time of the accident, these devices had been applied to about 2 or 3 percent of the Heritage equipment. The Amfleet 2 cars were expected to be delivered in June 1988 at which time Amtrak would begin to apply the baggage restraints; the baggage restraints were being applied to Amfleet 1 cars at the time of the accident. On August 9, 1988, the Safety Board responsed to Amtrak that "while it appears that test restraint devices would prevent the longitudinal movement of luggage, the full effectiveness of the device has not been

evaluated since there has been no testing regarding the lateral displacement of luggage. The Board fails to understand Amtrak's rationale for not conducting an in-depth and thorough evaluation of various luggage restraint concepts."

The four on-board service personnel had received first-aid and emergency evacuation training. The conductor stated that train crewmembers are given training, using a film, each year on the evacuation of a train. The conductor stated that the evacuation was orderly and was accomplished without incident; however, a passenger testified he thought the Amtrak personnel were too aggressive in attempting to get the passengers off the train. He said it would have been better to have allowed the passengers to remain on board the train because of the cold weather until the buses arrived so that rescue personnel would have had an opportunity to examine each of the injured passengers. No passenger reported any difficulty in leaving the train, except for walking on uneven icy terrain outside the train.

Emergency Response

A local resident notified the Delaware County Fire Board (DCFB) by telephone of the accident. The first unit, an engine company from the Chester Fire Department (CFD), dispatched at 0036, arrived on scene and confirmed the occurrence and location of the accident. Two engine companies, one ladder truck, one ambulance with paramedics, and a shift commander responded. The engine company immediately began a search of the train and established an area for triage to examine and classify the injured. The shift commander took command of the rescue operations when he arrived on scene at 0040. He notified the DCFB by radio and requested that Amtrak be contacted to stop all traffic and to send personnel to tend to the damaged catenary system. The chief of the CFD was then notified and he arrived within 10 minutes.

The first arriving paramedic unit, from Sacred Heart General Hospital, began medical triage inside the train and relayed all information to the ground triage site which was staffed by a paramedic unit from the Crozer-Chester Medical Center. The ground triage site coordinated all medical rescue efforts, which included calling additional ambulances as needed, ensuring that all patients were transported according to their priority, coordinating with area hospitals, and sending ambulances to the hospital best able to receive them according to injury and patient load already at the various hospitals. All passengers requiring medical attention had been transported to the hospitals within 1 hour following the accident.

Tests and Research

An examination of the expanded version of the Pulse tape printout for the lead locomotive of train 66 revealed that the speed rarely exceeded 90 mph. Average speed between Baltimore and Aberdeen was only about 75 mph. Between Bell and the point of collision, the maximum train speed was between 88 and 90 mph. The train speed at the time the train went into emergency braking was approximately 87 mph. There was no indication on the tape to indicate impact with the ballast regulator.

Maintenance records for the locomotives were examined; no problems or defects were found. Records also were examined for any recurring vehicle safety problems; none were found.

Predeparture inspection records were examined. Train 66 equipment had received a mechanical inspection and airbrake test before departure; no discrepancies were found.

The cab signal equipment was examined and photographed. A light bulb from each signal was removed and examined at the Safety Board's laboratory in Washington. An examination of the cab signal bulbs indicated that the restrictive signal was lighted at the time of the accident.

A test was conducted to determine if a similar ballast regulator would shunt the track circuit on track 2. A ballast regulator that met the same specifications as the destroyed ballast regulator was used for the test. During the test, the ballast regulator traveled northward from Hook interlocking to the bridge approach at Moore and then returned south to the Highland Avenue station platform, the location of the collision. Observers were stationed at the signal relays in the lower level of Hook tower and at the operator's board on the upper level. The test ballast regulator did not shunt track circuitry during the test.

A sight distance test was conducted on February 10, 1988, between 12:30 a.m. and 1:30 a.m. under an overcast sky. A ballast regulator and an AEM-7 locomotive were used. The test began with the ballast regulator located at the south end of the station platform at Highland Avenue with the plow end facing south and with both headlights and the yellow revolving light illuminated. This point was 2,823 feet south of MP 15. The locomotive was operated northward on track 2 toward the ballast regulator until it was at the point of the collision. The locomotive was then backed away from the ballast regulator southward until it reached the farthest point where it could be determined that the regulator was on the same track; this distance was 2,843 feet. This measurement was made where the reflection of the headlights of the ballast regulator could first

be seen on the head of the rails of track 2 and was a static test with both pieces of equipment stopped.

A second sight distance test was conducted to determine when the lights of the ballast regulator could first become visible; this distance was measured at 3,138 feet. The shape of the ballast regulator could be distinguished at 780 feet.

The lights of the ballast regulator could not be easily identified because of lights from an adjacent refining plant east of the tracks, street lights from adjacent streets and cross streets at the undergrade at Booth and Highland streets, and lights of the Commodore Perry bridge located north of the accident site. The yellow revolving light of the ballast regulator did not enhance its visibility. The cab signal of the locomotive displayed a clear indication as the locomotive moved north with the ballast regulator standing at Highland Avenue station platform.

A track barricade shunting test was performed by placing a track barricade on track 1 within the interlocking and north of the insulated joints[15] of the home signal.[16] The tower operator was requested to display the signal, which then displayed clear. A track barricade was placed on the head of the rails; it did not shunt the track. The clamps of the barricade were tightened to the rail; it did not shunt the signal circuitry and the signal continued to display a clear indication. The barricade, which was subsequently moved back and forth on the rail did shunt the track and the signal indicated stop. A signal maintainer was assigned to observe the relays to confirm that the track circuitry was shunted. After the signal had indicated stop, the signal maintainer continued to watch and 60 seconds after the signal went to stop, it returned to clear; the track barricade stopped shunting the signal circuit.

An examination of the transcript of the tape of the hard wire communication between the dispatcher and the tower operator revealed that the second- and third-shift operators were not reporting to the dispatcher each time they performed BDA and BDR operations on signals and switches. The transcript of the dispatcher's communication line recorded tape did not contain any communication from the operator at Hook to indicate the time train 66 passed that location, nor did it contain any recorded message from the Hook operator to the Phil operator advising when train 66 went by Hook tower.

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[15] A rail joint in which material has been applied to prevent the flow of electric current between adjoining rails.

[16] A fixed signal at the entrance of a route or block to govern trains or engines and using that route or block.

Undesirable Intrusion of Out-of-Service Track

Numerous requests were made to Amtrak management, and employees and their representatives to furnish any incidents in which an undesired intrusion of an out-of-service track had occurred before this accident. The employees and their representatives indicated there had been incidents in which trains had entered out-of-service tracks when maintenance-of-way employees were working; however, the Safety Board never received the requested dates and locations of the alleged incidents. Amtrak did furnish the Safety Board with a report of four incidents that occurred between 1985 and 1986.

- On March 25, 1985, an engineer of train 150 failed to control the speed of the train as it approached Lord temporary block station and entered track 2 east of Lord which was out-of-service for track maintenance.

- On March 26, 1985, an operator at Edgewood failed to properly block all switch and signal levers protecting track 3 south of Bush which was out of service for maintenance resulting in Conrail train extra 3219 being routed onto the out-of-service track.

- On December 4, 1986, an operator at North Philadelphia failed to properly protect the movement of maintenance-of-way burro crane 3327 within the interlocking, resulting in SEPTA train 77030 being routed against the burro crane.

- On December 9, 1986, an operator at Thorn failed to protect obstructing track on the P&T branch, resulting in Conrail train extra 9404 being routed to the P&T branch and striking a maintenance-of-way backhoe.

ANALYSIS

The Accident

The central issue in this accident is the protection provided to trains, personnel, and equipment during periods when the track is taken out-of-service. Amtrak operating rules are intended to prevent the intrusion of trains onto track that is occupied by maintenance-of-way equipment or otherwise out of service. The basic requirements of the rules are to place the track out of service and to position the appropriate signals and switches so that all trains will be routed to an alternate track to bypass the work area.

On January 28, 1988, track 2 north of Hook interlocking was taken out of service so that it could be occupied by on-track maintenance equipment and work crews. The Safety Board determined that the procedures used by all parties to take the track out of service were in accordance with Amtrak rules and instructions. The second-shift Hook tower operator, who was acting upon the request of a track foreman, placed signal 14L to display a stop aspect and placed a blocking device on the signal lever; he also placed blocking devices on switches 15 and 23, which were aligned normal to preclude trains from crossing to track 2 from tracks 1 and 3. He then requested permission from the second-shift train dispatcher to place track 2 out of service. The train dispatcher then issued the proper train order to the Hook tower operator, the Penn train director, and the maintenance-of-way track foreman. The tower operator was not required to reverse switches 7 or 13 to route trains away from the out-of-service portion of the track 2. Thus, switches 7 and 13 remained aligned so that the only protection against northbound trains approaching the out-of-service track on track 2 was the stop aspect of signal 14L.

The second-shift Hook tower operator verbally informed the train dispatcher that the appropriate blocking devices were applied. The train dispatcher thereafter made the appropriate entries on the train sheets and the train order book to indicate the completion of the train order and the signal and switch BDAs. Train order 920 was properly issued to the track foreman. The ballast regulator was later moved onto track 2 on the instructions of the track foreman possessing the train order. No track barricades were installed.

Between the time track 2 was taken out of service and the accident, shift changes were effected at both the Hook tower operator position and the train dispatcher position. Testimony by both the second- and third-shift Hook tower operators indicated that they had discussed the out-of-service track 2 during the change of shifts although they did not comply with an Amtrak rule requiring the oncoming operator to read aloud the

out-of-service train order to the operator being relieved. The Safety Board believes that this failure to adhere to the required turnover procedure was not uncommon, but rather was routine. However, because evidence indicates that the third-shift operator was aware of the out-of-service status of track 2 and the position of signals and switches within the interlocking when he assumed the operator's duties, the Safety Board concludes that the failure of the tower operators and dispatcher to adhere to the required turnover procedures did not contribute to the accident.

While all of the involved parties adhered to Amtrak rules and procedures during the initial process of taking track 2 out-of-service, the evidence indicates that neither the second- nor third-shift train dispatchers or Hook tower operators adhered strictly to the rules thereafter. In addition to the omission of the train order read-back confirmation during the Hook tower shift relief, the oncoming tower operator (third shift) did not notify the second-shift train dispatcher regarding his understanding of the train order in effect, and the second-shift train dispatcher did not ask the tower operator for such a readout, nor did the oncoming third-shift dispatcher discuss the effective train order with the Hook tower operator or the Penn train director as he was required to do after his position relief. Furthermore, none of the personnel adhered precisely to the requirements for the signal and switch blocking device removals that were made to accommodate train movements through the Hook interlocking. Some of these train movements required the removal of blocking devices to reposition signals and switches. Each time the devices were removed, permission should have been recorded on the Hook tower operator's block sheet and the train dispatcher's train sheet. Several instances were noted where the practice was not followed.

The Safety Board believes that, despite the procedural omissions, the signal aspect for signal 14L and the position of switches 15 and 23 were in accordance with the track 2 out-of-service train order, and the blocking devices were properly applied to their respective levers at 12:27 a.m. when the Hook tower operator was advised that train 66 had passed Bell and was approaching the Hook interlocking. The third-shift tower operator was then responsible to properly align the track. This required him to reposition switch 7 to cross train 66 from track 2 to track 1 and to reposition lever 14L to remove the stop aspect from signal 14L, which necessitated the removal of a blocking device from 14L; Amtrak rules required that this action be coordinated with the train dispatcher. These actions should have been taken in this sequence (although not required by rule) because, once signal 14L is changed to indicate an aspect other than stop, switch 7 cannot be reversed for a prescribed time interval. This prescribed time interval is a safety feature designed to prevent an approaching train from receiving a clear

signal and then suddenly encountering, while still traveling at a high speed, a signal change to a more restrictive signal because of the reversal of a switch. In light of the operator's previous experience, he should have been aware of the need to adhere to the proper sequence for the switch and signal lever movements. However, the tower operator neglected to reposition switch 7 to properly align the track for the crossover from track 2 to track 1 before he removed the blocking device from signal 14L and repositioned the signal lever. Furthermore, the operator did not coordinate the BDR with the train dispatcher as required.

If switch 7 had been reversed for a crossover movement to track 1 as train 66 passed the Hook tower, its speed would have been limited to 40 mph by the operating rules; the high rate of speed of train 66 as it passed the tower should have been an indication that the switch had not been reversed and the signal was displaying a clear indication. Had the tower operator recognized this, he could have immediately attempted to contact the train engineer by radio to stop the train. As train 66 approached the point of collision, the sight distance was not sufficient for the engineer, who was unaware of the status of track 2, to stop the train before the collision. The test of the cab signal bulbs taken from the lead locomotive indicated the bulb for a restricting indication had been lit. The testing of the signal and the track switch systems also indicated that both functioned as designed. The Safety Board believes that the evidence indicates that the cab signal had been displaying a clear indication at the time of the impact with the ballast regulator and changed to restricting as a result of the derailment.

Train 66 intruded onto the out-of-service track and collided with the ballast regulator as a direct consequence of the Hook tower operator's failure to operate the 7 switch lever and properly align the track for the crossover before removing the stop aspect from signal 14L. The Safety Board determines that this failure by the third-shift tower operator at Hook tower was the primary cause of the accident, raising questions about the performance of the tower operator.

Tower Operator Performance

The task of aligning the track before removing the stop aspect from a controlling signal was straightforward and routine for an experienced tower operator. Because the third-shift Hook tower operator failed to properly accomplish this task, the Safety Board examined those factors that might explain this failure. These factors include the operator's suitability for the job, his physical and mental state (including the use of drugs and the possibility of fatigue), the instant workload, and the possibility for distraction from his duties as a result of the presence of persons in the tower.

Amtrak considered the operator to have been qualified under its rules to perform the tower operator's duties. The operator had passed his annual physical examination, had received all of the required training, and had experience in the tower at the Hook interlocking. Thus, although Amtrak personnel records did not indicate that the operator was qualified at Hook tower (and Media tower) this appears to be primarily a recordkeeping problem. Further, he had been employed in that capacity for 7 years and his record showed no prior misrouting errors. His disciplinary problems appeared to be related only to his nonavailability for work at times when he was supposed to be on call for duty assignments. However, the Safety Board also recognizes that an employee's excessive absenteeism often can be an indication of problems which could affect job performance.

Although Amtrak had considered him to be qualified and he had no record of improperly performing his job task, the Safety Board is concerned that the third-shift tower operator was not well suited to the critical demands of the safe operations of a railroad. Other tower operators stated after the accident that they were not surprised that this particular operator was confused by the events of January 29, 1988. The operator did not take any action to control any distractions that may have been posed by other employees in Hook tower. He previously had indicated that the job was stressful, particularly the irregular schedule that he often encountered as an extra operator which required he work on the first-in, first-out schedule. The operator had, in fact, attempted to find other employment but remained on the job because of pay.

The Safety Board believes that the operator's performance, his uneasiness about the duties of the job, and his excessive absenteeism, were indicators of possible unsuitability for the job that should have been addressed by Amtrak supervisors, especially through its performance appraisal system. Accordingly, Amtrak should review its requirements and standards for the suitability and qualifications for tower operators before and after individuals are employed for that position.

The tower operator's work record indicated that he had been on vacation for 1 week before the night of the accident. However, the previous week's daily routine for his sleep cycle was disrupted on his first day back to work. He had been awake continously for about 14 hours when he reported for his work shift at a time when normally he would have retired. Thus, fatigue and degradation of mental alertness, both of which are known to occur when the daily sleep cycle is disrupted, could have been factors in his performance. The operator told Safety Board investigators that he felt tired and apprehensive when he reported for work but qualified the statement by adding that it was not unusual for him to feel tired when working the third shift.

The Safety Board acknowledges that there are no easy means to reduce the potential for fatigue in workers who frequently work irregular shift assignments from the extra board. However, the Safety Board believes that Amtrak should review its assignment procedures to determine whether they can be enhanced to minimize these circumstances. Where possible, workers should be notified of assignments with sufficient lead time for them to adjust their rest cycles. Further the Safety Board believes that safety could be enhanced if Amtrak would develop and institute, for all employees required to work irregular shift assignments, an educational program on how to properly manage their rest and diet during their off-duty hours.

The Safety Board also considered the possibility that the tower operator's performance was impaired as a consequence of a chronic or periodic use of drugs. This concern was prompted by the operator's act of abandoning the tower soon after the accident and the subsequent positive toxicological results showing that he had used three different drugs. Metabolites of marijuana and cocaine were found in his urine. In addition, methamphetamine and its metabolite (amphetamine) were found in the urine. Only the metabolite of marijuana was found in the blood.

All three drugs could have been used before and/or after the accident. It is known that chronic or habitual users of marijuana excrete marijuana metabolities in the urine for many days after last use because this drug is stored in the fatty tissue. After the last use, the marijuana is slowly eluted from the fat and the metabolite is eliminated in the urine. Similarly, depending on the frequency of usage, the metabolite of cocaine, benzoylecognine, can also show up in the urine for days after the last use. Methamphetamine and amphetamine (an active metabolite of methamphetamine) have relatively long half-lives (up to 34 hours); these drugs too will be detected for some days after use.

The Safety Board believes that it is highly unlikely that a "naive" or occasional user of drugs would have used three different drugs--marijuana, cocaine, and methamphetamine) within a 3-day period--the time between the accident and the provision of the toxicological sample. Consequently, it is more likely that the tower operator was an habitual user of marijuana and cocaine, in which case the metabolites of both drugs would have been detectable in his urine 3 or more days after his ingestion of the drugs. Although this alone is not conclusive that he had used the drugs sometime before the accident, his actions on the night of the accident, his record of absenteeism, and his lack of sleep for 14 hours before reporting to work, are consistent with the use of these drugs. Thus, the Safety Board concludes that the tower operator may well have used drugs before the accident

and that his performance on the job may have been affected by this drug use.

Within the first hour after assuming his duties, the tower operator was confronted with three train movements: SEPTA local train 9264, which had been south of the Hook interlocking, traveled north through the interlocking on track 1 at 11:32 p.m.; southbound SEPTA local 0265 which approached the Hook interlocking from the north on track 4 was to be crossed over at the interlocking to track 1; and northbound Amtrak train 66. The operator was also anticipating further movements of the maintenance-of-way equipment from track 2 to track 3.

Normally, this sequence of train movements would have presented the operator a routine workload with sufficient time to sequence and coordinate his tasks. The northbound movement of SEPTA local 9264 on track 1 required no actual action by the operator. To cross SEPTA local 0265 southbound from track 4 to track 1, the operator would have had to reverse switches 11, 13, and 15. This would have required the operator to request and receive a BDR on switch 15 from the train dispatcher. Although the evidence indicates that this required BDR coordination was not effected, the operator must have attempted to reverse switch 15 because he reported to the dispatcher that the switch was frozen and would not reverse. However, the operator's report of a frozen switch may have been due to his unfamiliarity with the idiosyncrasies of the switch. According to the second-shift operator, the lever for switch 15 was difficult to operate.

The operator's inability to reverse switch 15 presented him with a more difficult situation. He was instructed by the dispatcher to bring SEPTA local 0265 south through the interlocking on track 4 and then work him off track 4, i.e., reverse switches 21, 23, and 7 to move the train northward through the interlocking. The operator was subsequently told to delay crossing train 0265 to track 1 until train 66 had passed the tower. The Safety Board believes that after determining that switch 15 was frozen, the operator returned the levers for switches 11, 13, and 15 to their normal position and took no further action until he was advised of the approach of train 66. This sequence of switch movements is consistent with the placement of SEPTA local 0265 south of the interlocking on track 4 and train 66 north of the interlocking on track 2 at the time of the accident.

Distraction of the tower operator that caused his concentration to be diverted from the handling of train 66 through the Hook interlocking could have been a factor in this accident. Several factors existed that may have contributed to this distraction: (1) the crowded conditions in the tower because of four individuals, in addition to the tower operator, in the limited space within the tower; (2) the requests being

made by the track foremen present in the tower to arrange for track 3 to be taken out of service and the release of track 2 when the ballast regulator arrived back at Hook; (3) the train dispatcher's several requests about the status of track 2; and (4) the signal maintainer's questions regarding the switch failure. The tower operator testified that he was distracted as train 66 approached Hook interlocking and that when he operated the 14L signal lever he should have been thinking about train 66 but was thinking about track equipment instead. It is normal procedure for track foremen to be in a tower to request authority from the tower operator to use tracks to perform maintenance. Also, it is not unusual for a signal maintainer to be in a tower as they are required to coordinate with the tower operator all their work to be performed within the interlocking. Amtrak does most of its track maintenance work between 10 p.m. and 7 a.m. Therefore, it is during these hours that track maintenance supervisors will be requesting authority to use tracks from the third-shift tower operators. The Safety Board does not believe these normal activities should have caused undo distraction if the tower operators had given priority attention to the movement of trains. However, the third-shift tower operator failed to exert any control over activities in the tower. The tower operator stated that, "I was trying to please everybody at once," and "most of the time you could throw somebody out, get mean or something. But I mean if you get mean with them and nasty, it's kind of hard to work with those people." The tower operator should have taken control of the situation in the tower and told those individuals in the tower to wait until train 66 passed before discussing the movement of the track equipment.

Although the Safety Board does not believe that this sequence of events presented an exceptionally demanding workload for a normally alert operator, it does note that the operator may have been concentrating on two pending train movements while he was supposed to be aligning the track and clearing the signal for train 66: the movement of SEPTA local 0265 from track 4 to track 1 and the movement of maintenance-of-way equipment to track 3. During the time the operator was attempting to resolve the complications presented by the frozen switch 15, there was a continuously distracting presence of people and conversations in the tower. The Safety Board believes that the operator's preoccupation with these pending tasks combined with the distracting activity in the tower probably were factors which produced additional stress and taxed his ability to concentrate on the job at hand. Further, the Safety Board believes that the use of drugs may have contributed to the tower operator's inability to cope with his situation at the time of the accident.

Redundancy and Means to Protect Out-Of-Service Track

Tower Operator/Dispatcher Coordination.--The success of Amtrak rules for routing trains around maintenance-of-way equipment depends on the coordinated efforts of the dispatcher who controls and monitors train movements, tower operators who have actual control of signal and switch positions, and maintenance-of-way employees who are involved in the track work. The procedures in effect on January 29, 1988, were essentially the same as those that were in effect on April 20, 1979, when another Amtrak passenger train collided with a Plasser track machine at Edison, New Jersey.[17] As a result of its investigation of that accident, the Safety Board concluded that "there were adequate rules and instructions to provide for the safe movement of a track machine if they were complied with." However, the Safety Board also concluded that "Amtrak's management provided little supervision to insure compliance of the rules." The January 29 accident has prompted the Safety Board to reexamine the adequacy of these rules and procedures, compliance with the rules and procedures, and specifically, the redundancy provided to eliminate the possibility that a single human error can result in a potentially catastrophic accident.

Amtrak rules provide safety redundancy by requiring that at least two persons are aware of the signal status and track alignment. If the rules are followed, the train dispatcher should be able to detect a tower operator's oversight in the event he or she does not properly position the signal and switch levers and apply blocking devices. However, proper verbal coordination between the tower operator and the train dispatcher is essential as there is no direct indication of signal or switch status to the dispatcher.

The Safety Board notes, however, that the train dispatcher is also responsible for maintaining safe operations and that the coordination required to ensure redundancy was not effected as train 66 approached Hook. While the third-shift train dispatcher was aware of the need to cross train 66 from track 2 to track 1 at the Hook interlocking to prevent its intrusion onto the out-of-service track, he did not initiate action to determine if the operator properly aligned the switches. Although the rules did not require that he do so, prudence dictates that he should have. The Safety Board believes (although it cannot conclude with certainty) that rigid adherence to the Amtrak rules regarding the coordination and verification of BDRs and BDAs may have prompted the Hook tower operator to recheck the alignment of switch 7 as

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[17] Railroad Accident Report--"National Railroad Passenger Corporation, Head-End Collision of Train No 111 and Plasser Track Machine Equipment, Edison, New Jersey, April 20, 1978" (NTSB-RAR-79-10).

he requested the BDR from signal 14L and, further, that such a request may have prompted the train dispatcher to request a recheck of switch 7 as he entered the BDR in his log. Certainly the safety redundancy intended by the rules was eliminated when the procedures were omitted. Consequently, the Safety Board determined that general noncompliance with the rules by Amtrak employees was a contributing factor in the accident.

The CETC system has eliminated the need for tower operators and the need for constant communication and coordination by the dispatcher with another person to accomplish the task of handling trains and equipment. The Safety Board sees the elimination of the tower operators as an advantage for the dispatchers in that dispatchers will be able to arrange all signals and switches for establishing routes without the need to coordinate with an operator at a remote location. The need to operate the switch and signal to cross over train 66 on the day of the accident would still exist with the CETC system. However, when a track is taken out of service, the section of track turns blue on the visual display of the CETC system to serve as a reminder, much like the blocking device does for the tower operator. If the CETC system had been installed to control the signals and switches of Hook interlocking on the day of the accident, the likelihood of this accident occurring would have been somewhat diminished; however, the same error could have occurred if the dispatcher failed to recognize that unshunting equipment was on the track and removed the blocking from the track. Therefore, the Safety Board believes that Amtrak must evaluate the systems and procedures used on the NEC to provide positive protection for trains and equipment and for undesired intrusions into out-of-service track sections. Although the CETC system would offer safety benefits greater than the tower operator procedures in effect at Hook interlocking on January 29, 1988, the CETC system does not provide the positive separation of trains that can be provided by an advanced train control system.

Use of Insulated Maintenance-Of-Way Equipment.--Unfortunately, the safety features of the automatic block signal system and the automatic train control system do not protect trains against collisions with maintenance-of-way equipment when the equipment is insulated to prevent shunting the track circuit. However, most maintenance-of-way equipment is intentionally designed so the path of electrical continuity between the rails is insulated. Thus, the presence of most maintenance equipment on the track is not detectable by the automatic block signal system, as was the case in this accident.

The philosophy of insulating maintenance-of-way equipment so that there is no shunt between the rails has been somewhat controversial. In 1977, Amtrak adopted a policy to purchase insulated nonshunting maintenance-of-way equipment because there was not always a positive contact between the rails and the

wheels of some of the lighter weight maintenance equipment and thus, no electrical shunt. Thus, the interaction of such equipment with the automatic block signal system was not reliable. Because the shunt was not reliable, segments of the railroad industry believed that it would be safer to insulate the equipment so that operating and maintenance personnel would know there was no signal protection. Thus, they would not develop a false sense of security which would cause them to become complacent about their adherence to other safety measures. The Safety Board believes that the protection provided by the automatic block signal system is essential to the prevention of human error-induced accidents. The Board is aware that other railroads use shunting maintenance-of-way equipment and still retain independent out-of-service track procedures for protecting trains from collision with maintenance equipment. The Board believes that this policy of using noninsulated equipment is preferable and that employee complacency can be avoided by aggressive management supervision. Accordingly, the Board is pleased that as a result of this accident, Amtrak's newly purchased maintenance-of-way equipment will be noninsulated and that as other shop maintenance is being performed on existing equipment, it will be modified to provide a rail-to-rail shunt.

Until such time that a reliable level of protection against out-of-service track intrusions can be ensured through the use of noninsulated equipment and positive shunting devices, the protection will depend solely on procedural rules. In fact, the Safety Board believes that Amtrak's operating rules and instructions for protection of on-track maintenance equipment should always be considered as the primary safety measure. Therefore, to the extent possible, the procedures should be designed so that there is minimum chance of human error.

Use of Track Barricades.--The protection to prevent trains from intruding onto out-of-service track can, under some circumstances, be provided by shunting the track using barricades so that the automatic block signal system will function. However, testing of the track barricades used by Amtrak to provide shunt protection, demonstrated that even if these barricades were properly applied, they would not provide a reliable shunt. The failure of the track barricade to effectively shunt the signal circuitry during the testing was an indication that the track barricade should not, in its present design, be used to provide shunt protection for employees working on out-of-service track. Amtrak did not dispute the failure of its track barricade to shunt reliably.

Further, the track foreman involved in the work at Hook interlocking at the time of the accident had not received any instructions on the use of barricades, and he was unaware of existing requirements for their use. Testimony also noted that the use of track barricades is not intended to provide protection

for the movement of on-track equipment to and from the work site, such as the movement of the ballast regulator. Consequently, the Safety Board determines that the track foreman's failure to deploy track barricades was not a factor in this accident since they were not required to be used under the existing conditions and were not reliable even when used.

However, the Safety Board believes that the technology exists for Amtrak to redesign and provide a positive shunting device for the protection of maintenance-of-way employees when working with on-track equipment on out-of-service track. Until such change is made to provide a track barricade that does effectively shunt, the instructions for use of the barricade should not indicate that it is possible to use them as a shunting device. The Safety Board urges Amtrak management to take actions to instruct maintenance-of-way personnel on the required use of barricades.

Pulling Fuses.--The procedure Amtrak instituted in October 1978, to require signal maintenance personnel to physically remove fuses to de-energize the track signal circuits caused trains approaching out-of-service track to receive a stop signal regardless of the position of the signal levers in the block tower. The procedure provided an additional safeguard to prevent an operator from inadvertently changing the signal aspect and permitting an out-of-service track intrusion. However, according to Amtrak the procedure was cumbersome. Personnel from the communications and signal department had to be available constantly when maintenance crews were working to remove and reinstall the fuses. Furthermore, the system still had to accommodate the movement of trains into the interlocking before they could be crossed over to alternate parallel tracks to bypass the maintenance area. The additional procedures needed to accomplish a crossover probably were not conducive to the movement of trains with minimum delay. Consequently, Amtrak discontinued the fuse pulling procedure in 1982.

Since this accident, Amtrak has reinstated the fuse pulling procedure. The Safety Board supports this action and believes that it provides safety redundancy to prevent accidents involving intrusion onto out-of-service track. The Safety Board is concerned that the incidents of intrusion onto out-of-service tracks in 1985-86 did not alert Amtrak management that the system had a critical flaw for human failures as demonstrated in the previously mentioned intrusions and did not take the action of pulling fuses following those incidents. If they had, this accident would not have occurred.

Reversing Switches.--When track 2 was taken out-of-service, switches 15 and 23 were aligned to prevent trains from entering track 2 from tracks 1 and 3. Blocking devices were applied to the switch levers as required. However, no actions were taken to

prevent northbound trains on track 2 from continuing straight onto the out-of-service section of track if the signal lever blocking device was removed and the lever activated. Amtrak considers the protection provided by placing the signal that controls entry to the out-of-service section of track to stop and aligning any switch leading from an adjacent track away from the out-of-service track to be adequate.

The Safety Board noted that a greater margin of safety could have been provided if either switch 7 or switch 13 had been placed in a reverse position with a blocking device applied when the track was taken out of service. Reversing either of these switches would have caused a northbound train on track 2 to have received a signal indicating the train was to cross over and be routed away from track 2 before it entered the out-of-service section of track. The tower operator would have now had to have taken a deliberate action to remove the blocking device and reposition the switch before the train's arrival in order for the train to intrude on out-of-service track. The removal of the blocking device would have required coordination with the train dispatcher. Safety would be enhanced by eliminating the possibility that an intrusion could occur because of an operator's failure to act. Further, trains approaching the interlocking would have the benefit of the automatic block signal system and automatic train control for collision prevention.

Amtrak stated that the adoption of a procedure that would have required the reversal of switch 7 or switch 13 at Hook interlocking would not be practical because the parallel track affected by the switch would not be aligned for through train movement. Consequently, Amtrak believes that there would be an increased workload on the tower operator and the train dispatcher in the coordination of BDRs and BDAs, and switch reversals to accommodate through train movements on these parallel tracks. Amtrak further believes this additional workload could, in fact, degrade rather than enhance safety. However, the reversing of switch 7 would have prevented a train from entering the out-of-service track, and this accident would not have occurred. Therefore, the Safety Board believes that Amtrak should evaluate such alternatives to determine if current procedures can be improved.

Train Orders.--Under Amtrak procedures, the engineers and conductors of trains operating through affected interlockings are not informed about out-of-service track by train orders or any other direct means. Amtrak officials at the public hearing on this accident testified that not notifying train crews of out-of-service track was acceptable since out-of-service track protection is not contingent upon actions by the train crews other than the normal compliance with signals, a rigid requirement under all circumstances. However, in response to a safety recommendation which was issued as a result of the Board's

investigation of a derailment at Fall River, Wisconsin,[18] the president of Amtrak stated,

> The Fall River accident, however, demonstrated that what is more essential than switch position in such operations is prior written notification to all trains approaching such locations, including a clearance provision for a train to pass the location. As the Board's report noted, the speed at which no. 8 was operating as it approached Fall River resulted not only from signal aspects but, also, and more importantly, from failure to provide written notification that a switchtender was on duty or that the train would be diverted. In such circumstances, if track beyond Fall River were occupied by track equipment or an opposing train and the crossover was in normal position, absence of notification could result is just as serious a potential for an accident.

The president of Amtrak further stated that in a situation, such as that at Fall River, Amtrak's procedure would be to require trains to obtain a bulletin order and a train order before passing the block station and that if this procedure had been used by the Soo Line, the derailment of train 8 would have been avoided. There is no substantial difference in the need for prior notification of the engineer in this accident and in the need for notification in the accident at Fall River. The engineer of train 66 stated that had he been issued a train order stating that track 2 beyond Hook was out of service, his authority would have been restricted to use track 2 only to Hook and he would have questioned the clear signal he received on track 2. This information would have prevented this accident. The Safety Board believes that it is the responsibility of Amtrak management to ensure the uniform use of procedures, such as that outlined by the president of Amtrak, throughout the railroad systems on which Amtrak operates trains.

Amtrak Supervisory Oversight

The Safety Board believes, this accident demonstrates a deficiency in the review and oversight by Amtrak management of the design of its equipment and adequacy of and adherence to its procedures. The design and manufacture of track barricades that do not provide a reliable shunt is an example of this deficiency. If the barricade does not shunt the signal

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[18] Railroad Accident Report--"Derailment of Amtrak Passenger Train 8 Operating on the Soo Line Railroad, Fall River, Wisconsin, October 9, 1986" (NTBS/RAR-87/06).

circuitry, it will not prevent a train from entering an out-of-service track. However, reliable techniques are available to shunt the track (a track foreman testified of using welding cable and clamps) that could have been incorporated in the design of the track barricades. The use of insulated maintenance-of-way equipment is further evidence of Amtrak's deficiency in the oversight of its operations. The failure to use train orders to alert engineers that a track is out of service and the train is going to be crossed over is still another example of the failure of Amtrak management to provide a readily available means of additional protection for the men and equipment working in the out-of-service track sections. Following the Fall River accident, Amtrak management criticized the Soo Line Railroad for not using train orders emphasizing that their use would have prevented the accident. However train orders also could have prevented this accident, but Amtrak's management did not require their use. The practice of pulling fuses when tracks were taken out of service eliminated another backup safety measure. This additional safety measure was eliminated without any other backup being put into practice. Amtrak management stated that it would depend on the operating rules to provide the needed protection. However, in this accident both the second- and third-shift train dispatchers and tower operators did not comply with the operating rules. The Safety Board does not believe that the failure of these four individuals (three on regular assignments and one extra) to comply with the procedures was an isolated accident. The Safety Board believes that these actions are a clear indication that Amtrak's management has permitted the elimination of redundant levels of safety that could have prevented this accident. Further Amtrak has not exercised proper oversight of its employees, thus allowing adherance to its procedures to decrease.

In the Edison, New Jersey accident,[19] the Safety Board concluded that the Amtrak rules were adequate to prevent the intrusion of trains onto out-of-service track. The Board qualified the conclusion by stating that the safety provided by the rules was contingent upon compliance with them by Amtrak employees. At that time, the Board believed that an acceptable level of compliance with the rules could be achieved by improvements in the supervision of employees by Amtrak's management. The Safety Board acknowledges that Amtrak's existing train control system in the Northeast Corridor has generally performed well, moving high speed trains quickly and relatively safely over millions of miles each year with few incidents. Nonetheless, the Safety Board is concerned that this accident and the Edison, New Jersey, accident illustrate the vulnerability of the existing train control system to human failure. Moreover, at the Board's public hearing on this accident, Amtrak officials

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[19] Railroad Accident Report--NTSB-RAR-79/10.

described four more instances of intrusions on out-of-service track in the Northeast Corridor during 1985-86. All of the occurrences were attributed to a failure of employees to follow prescribed procedures and, in all cases, disciplinary actions were taken against the employees responsible. The Safety Board believes that procedural errors which can or do result in the intrusion of a train onto out-of-service track may occur even more frequently than the accident/incident data show as some may remain unreported by employees who fear disciplinary measures by Amtrak.

The Safety Board believes that any system that relies totally on human performance is subject to breakdown irrespective of the intended redundancy provided for in the system. At the time of the accident, the only redundancy in the Amtrak rules to prevent the intrusion of trains onto out-of-service track in the Hook interlocking was the required coordination between the train dispatcher and the tower operator and the use of the blocking devices on appropriate signal and switch levers. However, neither the train dispatchers nor the tower operators adhered strictly to the rules. Train orders were not read back during shift relief, and the requests and coordination procedures for removing signal and switch blocking devices were not followed. The Safety Board believes that a general disregard for these rules may have evolved over time as employees attempted to streamline their actions to keep trains moving without delay. The Safety Board could not find evidence that Amtrak supervisors routinely examined dispatcher train sheets and tower operator logs to ascertain that the BDA and BDR coordination rules were being followed, nor that they were conducting efficiency checks of operator and dispatcher performance. For example, the Safety Board has no evidence of such efficiency checks being made on the operator involved in this accident since the three efficency checks that were conducted between October 1, 1980 and October 14, 1985. Amtrak stated that only one check was performed in 1987; the Safety Board, after repeated requests to Amtrak, has been unable to get a copy of this efficiency check.

In its safety assessment of corridor operations, the Federal Railroad Administration (FRA) found that operational efficiency checking appeared to be "nonexistent" and that Amtrak imposed no efficiency checking requirements on its operating officers. The FRA assessment also stated that efficiency checks that would interfere with schedule requirements were not conducted, and that some Amtrak supervisors stated they believed they would be disciplined if checks delayed a train. In 1985, Amtrak responded to this evaluation by stating that it intended to increase efficiency checks, but that it would not require a specific number of checks to be conducted in a fixed period of time. Following the FRA safety assessment and Amtrak's response to that assessment, Amtrak experienced the worst accident in its history at Chase, Maryland, on January 4, 1987. In its report of that

accident,[20] the Safety Board concluded that Amtrak had a very limited program of oversight and supervision of its employees on the corridor. The Safety Board further concluded that the deficiencies suggested that Amtrak's concern with on-time performance may, at times, have had a detrimental effect on safety. As a result of its investigation of the accident, the Board recommended that Amtrak:

> R-88-3
>
> Expand and intensify supervision and management of train operations on the Northeast Corridor to include mandatory speed and signal compliance checks and regular supervisory crew fitness checks at reporting points and enforcement of compliance with the requirements of post-accident testing of employees for alcohol and drugs.

Amtrak responded to this recommendation on October 27, 1988, that:

> We must reiterate that our position on supervisory crew checks remains unchanged, we will review the procedure, described by the Board as being used on several railroads, as a method to better control drug and alcohol abuse by operating employees. After review, we will advise the Board of our views relative to such a procedure.

As a result of its safety study on alcohol/drug use and its impact of railroad safety,[21] the Safety Board recommended that the members of the Association of American Railroads:

> R-88-34
>
> Require supervisors to review computerized crew dispatching and related work records and motor vehicle driving records to evaluate employee work habits and absenteeism as part of a documented program to identify employees in safety-sensitive positions who may use alcohol and/or drugs.

---

[20] Railroad Accident Report--"Rear-end Collision of Amtrak Passenger Train 94, The Colonial, and Consolidated Rail Corporation Freight Train ENS-121, on the Northeast Corridor Chase, Maryland, January 4, 1987" (NTSB/RAR-88/01).

[21] Safety Study--"Alcohol/Drug Use and Its Impact on Railroad Safety" (NTSB/SS-88/04).

In its response, dated August 31, 1988, to Safety Recommendation H-88-34, Amtrak stated:

> Its belief that supervisory review of crew dispatching records, work records and incidents of excessive absenteeism to be beneficial in establishing trends in employee work habits. Amtrak has established a computerized reporting system that highlights those Northeast Corridor (NEC) train crew employees who have marked off two or more days in any work month. These reports are reviewed by each NEC division's management on a regular basis. Work records and disciplinary records are reviewed regularly on all divisions. The NEC computerized absenteeism reports are being monitored and evaluated for effectiveness before expanding it to include non-NEC operating personnel.
>
> Motor vehicle driving records for employees may or may not be accessible for Amtrak review. Amtrak is now in the process of determining this and assessing the administrative procedures required to adequately review such records.

Safety Recommendation R-88-34 is being held in an "Open--Acceptable Action" status pending further reports on progress in addressing the issues raised in the Amtrak's response. However, the Safety Board believes that Amtrak should accelerate its assessment process because the circumstances of this accident demonstrate the need for this type of monitoring of all employees in safety-senitive positions, such as the tower operator involved in this accident, and not just crew employees.

The Safety Board concludes that, after the Edison, New Jersey accident, the Chase, Maryland accident, and this accident, Amtrak's management has continued to provide insufficient supervision to improve the level of compliance with its operating rules. The Safety Board reiterates safety recommendation R-88-3 and believes that train dispatchers and operators should also receive intensified supervision and efficiency checks for compliance with the operating rules.

The Safety Board's concern about the adequacy of Amtrak management's supervision of employees was heightened by the postaccident examination of the tower operator's personnel records. Significant records attesting to the operator's competency and proficiency tests were not located. The lack of records that indicated the third-shift operator's qualification

at Hook and Media towers and letters prescribing disciplinary measures for the employee's nonavailability for work when in a standby status were inaccurate and incomplete. The Safety Board believes that Amtrak's management of personnel records, while meeting the requirements of the FRA, was not sufficient to evaluate employee performance.

The failure of Amtrak to correct the operator's attendance is an example of a lack of supervision of the employee. The operator had reason to expect that even if given suspensions for excess absenteeism he would not be punished because of Amtrak's failure to put previous suspensions in effect. Also, the lack of progressive discipline of the tower operator would appear to indicate that he had improved his reporting for duty when in fact he had 14 incidents of missed calls for failure to report during a probationary period. Following a previous dismissal, he was returned to work with the requirement that if he missed a call or failed to report for work he would be dismissed without the right to appeal. The records do not indicate he had received any counsel or assistance from Amtrak during his employment for this problem. Amtrak did not discipline the employee nor fulfill its responsibility to oversee the operator's on-the-job conduct and performance.

The Safety Board believes that the Amtrak safety department should be used more effectively; specifically, it should not be excluded from inputs in train operations. Following the Chase, Maryland accident, the Safety Board concluded that there was "little doubt that Amtrak's safety department was primarily involved in preventing employee injuries and implementing emergency response and other educational programs with outside organizations ... Amtrak's safety department should have also been concerned with promoting operational safety." Also following the Chase accident, the Board recommended that Amtrak:

> R-88-4
>
> Reassess and restructure its safety program to provide a greater role for safety considerations in all aspects of its operations.

On October 27, 1988, in response to this recommendation the president of Amtrak stated in a letter to the Safety Board that:

> ...each safety manager is proficient in operating rules and monitoring train operations ... Division safety personnel will be fully qualified on NORAC[22] rules and will continue to monitor train operations.

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[22] Northeast Operating Rules Advisory Committee.

The statement by the manager for safety of the Philadelphia division at the public hearing conducted on this accident, that the safety department did not play a role in monitoring the operation of trains or operating employees, clearly indicates that the safety department personnel do not have responsibility for safety in the operating department. The Safety Board believes that the safety department should have the duties defined by the president of Amtrak in his October 27, 1988, response to the Safety Board.

While the Safety Board believes the duties of the safety department personnel specified in the letter of October 27, 1988, is a step in the proper direction, more needs to be done. The safety department of Amtrak should include individuals with expertise in systems designs, analysis of human performance, and system safety. Experience in other industries has shown that benefit can be obtained from interaction between those who have expert knowledge in operations, those who have expertise in system design, and those with knowledge in human performance. Despite the response received from Amtrak on October 27, 1988, the Safety Board is concerned about Amtrak's use of its safety department and believes that Amtrak should re-examine the role of its safety department.

Survival Factors

Passenger testimony at the Safety Board's public hearing on this accident, described the initial impact as sharp. The impact that they described was probably the application of emergency braking since going from a steady speed to emergency brake application was very abrupt and noticeable; the actual impact with the ballast regulator was probably not noticeable given the great difference in mass between the train and the ballast regulator. Further, the speed tape showed no perceptible deceleration at impact. Therefore, the Safety Board concludes that few injuries occurred at impact.

Following that impact, the deceleration was relatively smooth, indicating that the train pushed the ballast regulator at a uniform deceleration. The only further abrupt, albeit small, changes in the deceleration were caused by the derailed cars bouncing along the crossties and striking items along the right of way when the train derailed. Additional injuries could have occurred at this time due to the jostling and bouncing experienced by the passengers which threw them out of their seats and into the floor and other interior surfaces of the cars.

The only occupant of the train to receive serious injuries was the engineer. Even though he was at the very front of the train, it is most likely that his more serious injuries were not caused by impact with the ballast regulator. Rather, the injuries occurred when the engineer was thrown about the cab when

the locomotive reversed direction and rolled down the embankment and when he was ejected from the locomotive through the opening where the windshield had been installed.

Seating Integrity

Many of the injuries appeared to be caused by passengers striking interior surfaces. The Safety Board noted that in this accident, as in other accidents, seatback cushions became dislodged when struck from the rear, exposing the sheet metal headrest support. Following its investigation of a head on collision in Astoria Queens, New York, New York, on July 23, 1984,[23] the Safety Board recommended that Amtrak:

> R-85-81
>
> Modify the coach seats used in Amfleet equipment so that seatback cushions cannot dislodge when struck and expose surfaces which can cause injuries in accidents.

The Safety Board is pleased that Amtrak is progressing with the modifications to the original type of seatback cushions in the Amfleet cars covered in Safety Recommendation R-85-81. Further, the seats in coach cars 21118 and 21205 involved in this accident had been modified to prevent persons from striking the sheetmetal edge should it be exposed. A sheet of plastic, about 1/8 inch thick had been formed over the entire width of the sheet metal headrest support and was riveted in place. The smooth, rounded outer surface of the plastic covered the sharp edge of the sheet metal. The Safety Board encourages Amtrak to do all it can to maintain the schedule so that the remaining 150,000 seats will be completed by end of 1989.

Another problem that may have contributed to passengers impacting interior surfaces was the failure of seat-locking mechanisms, which caused undesired rotation of the seats and allowed the passengers to be ejected from their seats. As a result of its investigation of the Edison, New Jersey accident, the Safety Board recommended that Amtrak:

> R-79-72
>
> Require that the seats of all Amfleet equipment are maintained in proper condition to insure that the seats are locked securely in place.

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[23] Railroad Accident Report--"Head-On Collision of National Railroad Passenger Corporation (Amtrak) Passenger Trains No. 151 and 168, Astoria, Queens, New York, New York, July 23, 1984" (NTSB/RAR/85-09).

Amtrak responded that it had designed and developed an antirotating device and had tested a prototype for production.

As a result of its investigation of a head-end collision at Dobbs Ferry, New York, on November 7, 1980,[24] the Safety Board recommended that Amtrak:

> R-81-58
>
> Install an adequate locking device on rotating seats which will prevent undesired rotation in accidents.

Amtrak responded on August 3, 1981, that it was progressing with the installation of antirotational devices on seats on Amfleet and Superliner cars during normal maintenance inspections and overhauls. On June 22, 1982, Amtrak responded that "... Superliners are equipped with anti-rotational locks ..." Despite these statements by Amtrak, Safety Board accident investigations continued to reveal that inadequately secured seats remained a problem.

As a result of its investigation of a collision of an Amtrak train and a delivery truck on July 28, 1983, at Wilmington, Illinois,[25] the Safety Board recommended that Amtrak:

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

Safety Recommendation R-84-40 was reiterated to Amtrak when similar problems were encountered as a result of the Safety Board's investigation of a derailment at Woodlawn, Texas, on

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[24] Railroad Accident Report--"Head-End Collision of Amtrak Passenger Train No. 74 and Conrail Freight Train OPSE-7, Dobbs Ferry, New York, November 7, 1980" (NTSB/RAR/81-4)

[25] Railroad/Highway Report--"Collision of Amtrak Passenger Train No 301 on Illinois Central Gulf Railroad with Marguette Motor Service Terminal, Inc., Delivery Truck, Wilmington, Illinois, July 28, 1983" (NTBS/RHR/84-02)

November 12, 1983.[26] On March 13, 1985, in response to Safety Recommendation R-84-40, Amtrak reported that as its coaches were overhauled; the locking devices intended to prevent seat rotation would be modified to include a positive locking feature that would prevent undesired rotation. Additionally, Amtrak reported that it was replacing complete car sets of seat frames with a design equipped with a step latch with a positive locking device that prevents the seat from falling away from the coach wall, as well as undesired seat rotation. Amtrak further reported that it would equip all newly constructed coaches with the improved seat frames. Based on this information and the Board's investigation of the Amtrak train derailment at Kittrell, North Carolina, on March 5, 1984,[27] which suggested that there had been some efforts to improve seatbacks and seatframes to prevent failures, Safety Recommendations R-79-72 and R-81-58 were ultimately placed in a "Closed--Acceptable Action" status. However, inasmuch as Amtrak at the time did not plan to retrofit the overhead luggage racks in its existing cars with retention devices, Safety Recommendation R-84-40 was ultimately placed in a "Closed--Unacceptable Action/Superseded" status, and a new recommendation, as discussed later, was issued in the report of the derailment at Essex Junction which specifically addressed luggage retention devices.

In response to questions asked during the Safety Board's deposition proceedings following the collision and derailment of an Amtrak train at Russell, Iowa,[28] Amtrak stated that the seatlocks developed in early 1981 and installed on 21 Amfleet cars and 34 of the original Metroliner cars were determined to be unsatisfactory. Another supplier developed a positive seat locking device that was specified on Amfleet II cars delivered through 1983. In addition, seats with the new seat locking device were purchased from the same supplier to replace deteriorated seats on the Amfleet I cars. These additions began in late 1984 during the 6-year overhaul program. On March 4, 1988, Amtrak tested a similar positive seat locking mechanism for installation on the remainder of its passenger car fleet. According to Amtrak as of April 1, 1988, no superliner cars had been equipped with a positive seat-locking device, and only

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

[27] Railroad Accident Report--"Derailment of Amtrak Train No 81, The Silver Star, on the Seaboard System Railroad, Kittrell, North Carolina, March 5, 1984" (NTSB/RAR-85-03).

[28] Railroad Accident Report--"Collision and Derailment of Amtrak Train 6 on the Burlington Northern Railroad, Russell, Iowa, October 27, 1987" (NTSB/RAR-88/04)

40 percent of the fleet had been so equipped since late 1984. As seen in the January 29, 1988, accident, the failure of seat locking mechanisms permitted undesired rotation of the seats and, thus, allowed the passengers to be ejected from their seats. Also, during the investigation of the Russell, Iowa accident, in a letter dated April 1, 1988, Amtrak stated to a Safety Board investigator that a newly designed seat lock which had been developed and successfully dynamically tested was to be supplied to Amtrak by June 1988 from a newly contracted supplier. The letter also stated that from 1984, the year the retrofit program began, until the date of the letter, about 1/3 of the entire fleet had received the latest design lock. The anticipated completion date for modification of the fleet (Amfleet, Heritage, and Superliner) by September 30, 1989, appears reasonable; however, given the fact that only 1/3 of the fleet has been modified thus far, after the passage of about 4 years, and another 11,000 locks remain to be installed, an aggressive program would be required, and, given the comparatively short time remaining, its successful completion would seem doubtful. The Safety Board believes that Amtrak should expedite the installation of positive seat-locking devices to achieve its anticipated completion date of September 30, 1989.

In addition to the problems of seatback cushions and seat-locking devices, the Safety Board is concerned about luggage being ejected from the overhead racks and causing passenger injuries.

Luggage Retention Integrity

The Safety Board has expressed concern to the FRA regarding the inadequacy of effective luggage retention devices in railroad passenger cars. As a result of its investigation of the train/delivery truck collision at Wilmington, Illinois, on July 28, 1983, the Board recommended that the FRA:

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

The recommendation was reiterated to the FRA following the Safety Board's investigation of the rear-end collision between a Boston and Maine Corporation commuter train and a Conrail freight

train near Brighton, Massachusetts, on May 7, 1986,[29] and again following the Board's investigation of the rear-end collision of Amtrak passenger train 94 and a Conrail freight train at Chase, Maryland, on January 4, 1987.

Following the Safety Board's investigation of the accident at Essex Junction,[30] in which overhead luggage falling from the racks was documented as a common cause of injuries, the Board addressed the following recommendation to Amtrak, in part because it appeared the FRA was reluctant to take any action on this issue as evidenced by its unresponsiveness to Safety Recommendation R-84-46:

> R-85-128
>
> Develop and install effective retention devices in its overhead luggage racks to prevent the dislodging of luggage and other articles in a collision and/or derailment.

On September 22, 1987, Amtrak informed the Safety Board that "... test luggage restraints have been installed on three car sets. Luggage restraints have been approved by Federal agencies. ... We estimate installation will take 6 years to complete." The Board noted during a visit to an Amtrak facility in October 1986 that the test restraint devices had some sharp protruding edges that could become an additional source of injuries, particularly if a car overturned.

On April 19, 1988, Amtrak responded to the Safety Board that:

> [it] has modified the design of its luggage retention devices to eliminate the sharp edges. ... Our investigation revealed that luggage moved longitudinally during derailments, then piled up and spilled into the car body.... By having the vertical stops on 81-inch centers and a raised side rail, the luggage will be successfully restrained.... With regard to the approval of this modification, there is no formal review process for such modifications. Arrangements were

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[29] Railroad Accident Report--"Rear End Collision Between Boston and Maine Corporation Commuter Train No 5324 and Consolidated Rail Corporation Train TV-14, Near Brighton, Massachusetts, May 7, 1986" (NTSB/RAR-87/02).

[30] Railroad Accident Report--Derailment of Amtrak Passenger Train No. 60, The Montrealer, on The Central Vermont Railway Near Essex Junction, Vermont, July 7, 1984" (NTSB/RAR-85/14).

made for representatives of both the Safety Board and FRA to review and attend a field test of the new system.

Amtrak's schedule shows that 22 cars of a scheduled 991 cars have had the modified luggage retention device installed as of the date of the response and that completion will vary from 1989 to 1991 depending on the car type.

Although the test restraint devices appear to prevent the longitudinal movement of luggage and Amtrak has eliminated some of the sharp edges, the full effectiveness of the devices has not been evaluated in a testing situation for an overturned car. Despite these concerns, the Safety Board continues to believe that once an adequate device has been evaluated and determined suitable, installation should be accomplished as expeditiously as possible in view of the fact that passenger injuries continue to occur as a result of luggage falling from the overhead luggage racks. Moreover, the Board is concerned with the FRA's most recent response to Safety Recommendation R-84-46, dated March 16, 1988, in that the FRA has endorsed Amtrak's current retrofit program, even though adequate testing and evaluation of the devices has not been done. The Board has urged the FRA to look into all possible solutions to the luggage retention problem and develop guidelines that would apply to any carrier involved in passenger rail service. Safety Recommendations R-84-46 and R-85-128 are currently being held in an "Open--Unacceptable Action" status.

While only a few passengers in this accident reported being struck and none reported being injured by baggage that had been ejected from the overhead racks, the lack of effective luggage restraints continues to allow luggage to be ejected and a source of injury.

CONCLUSIONS

Findings

1. The procedures for blocking the signal and switch levers were not sufficient to prevent the operator from operating the signal lever before reversing switch 7 and to alert the third-shift Hook tower operator that he had not reversed the crossover from track 2 to track 1 for the movement of train 66.

2. The operator removed the blocking device and had operated the signal lever without reversing the 7 switch because he probably was distracted, impaired from drug use, or a combination of both.

3. The operators' practice of removing and replacing blocking devices without notifying the dispatcher indicate that Amtrak is not properly enforcing its operating rules.
4. The engineer operated train 66 in accordance with signal indications.

5. The issuance of train orders for the out-of-service track to the engineer of train 66 could have alerted him of the need for his train to be crossed over and could have prevented this accident.

6. The equipment operator and foreman were proceeding south on track 2 with the understanding that protection had been provided.

7. Because the ballast regulator was insulated to prevent shunting of the signal circuits (Amtrak had made a decision to purchase insulated track equipment), the protection that could have been provided by the automatic block signal system was eliminated.

8. Amtrak's discontinuance of the practice of pulling fuses to protect out-of-service tracks eliminated additional backup protection that could have prevented this accident.

9. Amtrak's safety department does not get involved in the practices and procedures of the operating department because Amtrak management determined that only operating officers were qualified to do so; this substantially reduced the overall effectiveness of Amtrak safety department.

10. Because of low-impact forces passengers received only minor injuries when the train derailed.

11. The train equipment, signals, and track had no defects that caused or contributed to the accident.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the third-shift tower operator at Hook tower, because of impairment by drugs or distraction or both, to operate the 7 switch to allow train 66 to crossover from track 2 to track 1 and the failure of Amtrak to provide positive protection for on-track equipment and out-of-service tracks. Contributing to the accident was Amtrak's failure to adequately monitor the activities and job performance of the tower operator.

RECOMMENDATIONS

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

- to the National Railroad Passenger Corporation:

  Expand and intensify supervision and management of tower operators and dispatchers, including, at a minimum, regular performance evaluation observations to improve the enforcement of compliance with the operating rules (Class II, Priority Action) (R-89-1)

  Establish standards for the selection, training, duties, and responsibilities of tower operators. (Class II, Priority Action) (R-89-2)

  Develop and implement a procedure to prevent locomotives or trains from entering out-of-service track sections unless permission has been received from the person in charge of the out-of-service track. (Class II, Priority Action) (R-89-3)

  Develop and implement a procedure for the prior notification of engineers and conductors when a track is out of-service. (Class II, Priority Action) (R-89-4)

--to the American Railway Engineering Association:

  Determine methods to provide for positive shunting of signal circuitry by on-track maintenance-of-way machinery, and include these methods in the manual of recommended practices. (Class II, Priority Action) (R 89 5)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES L. KOLSTAD
Acting Chairman

/s/ JIM BURNETT
Member

/s/ JOHN K. LAUBER
Member

/s/ JOSEPH T. NALL
Member

/s/ LEMOINE V. DICKINSON, JR.
Member

January 6, 1989

APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The Safety Board was notified of the accident at 2 a.m. on January 29, 1988, and immediately dispatched an investigator from the New York field office to the scene. Also a Safety Board member, the investigator-in-charge, and other members of the investigative team were dispatched from Washington, D.C. Investigative groups were established for operational, track and signals, vehicle, human performance, survival and emergency response, toxicological, and weather.

Hearing

The Safety Board convened a 3-day public hearing as part of its investigation on April 27, 1988, at King of Prussia, Pennsylvania. Parties to the hearing included the National Railroad Passenger Corporation (Amtrak), the Federal Railroad Administration (FRA), the Brotherhood of Maintenance of Way Employees, and the Transportation and Communications International Union.

APPENDIX B

CREWMEMBER INFORMATION

Mark B. Kenny, Engineer Train 66

Mr. Mark B. Kenny, was employed by Conrail on February 28, 1977, and was promoted to the position of engineer in August 1979. He operated Conrail freight trains and SEPTA commuter trains. In 1984 when Amtrak took the train crewmembers into its employment, Mr. Kenny transferred to Amtrak and has been operating Amtrak passenger trains since that date.

Thomas A. Connor, Third-Shift Hook Tower Operator

Mr. Thomas A. Conner, was employed by Amtrak on July 17, 1980, as a tower operator. On August 28, 1980, he completed the training for operator position and began a series of on-the-job training in various towers. He has been working as an operator for 7 years.

R. C. Douglas, Second-Shift Hook Tower Operator

Mr. R. C. Douglas, 58, was employed by Conrail May 16, 1972, as a tower operator. He transferred to Amtrak when took over the NEC on October 1, 1976. Mr. Douglas had worked as a tower operator since beginning his employment. On November 1, 1986, he received a 15-day suspension for failing to display the 14R signal at Hook interlocking, for failure to place the 7 switch for crossover movement, for failure to secure and block all switches in the proper position, and for removing a blocking device without the train dispatcher's permission.

Floyd Vincent Bucci, Third-Shift Train Dispatcher

Mr. Vincent Bucci, 37, was employed by Amtrak as a tower operator on October 6, 1976, and was promoted to train dispatcher on January 9, 1982. On May 18, 1983, he received a 30-day suspension for failure to properly protect the safe movement of train TV-24. On May 11, 1983, he received a 15-day suspension for failing to transmit train orders, and on July 19, 1984, he received a reprimand for failing to record BDR's. On June 21, 1987, he received a 2-day suspension for failing to protect by train order a speed restriction.

Catherine R. Cephas, Second-Shift Train Dispatcher

Miss Catherine R. Cephas, 32 was employed by Amtrak on June 29, 1978, as a tower operator; she was promoted to train dispatcher in July 1981. The only discipline in the personel file indicated she had received a reprimand on July 28, 1981, for failure to report for an assignment.

APPENDIX C

TRAIN ORDER 920 AND DISPATCHERS LOG SHEET FOR TRAIN ORDER 920

FORM 19

NORTHEAST CORRIDOR

TRAIN ORDER NO 920

Jan 28 1988

FORM 19

TO Opr Jm Foreman H Huber

AT Hack.

No 2 Track out of Service between Hack Tower, Phil but may be used with authority of Foreman Huber but Rules on No 2 Track at Bridwin are not in effect.

CCB

Acknowledged By

Q13

MADE C777 TIME 1006 PM OPERATOR Douglas

NEC 262:5/82

Page No 96

AMTRAK—NORTHEAST CORRIDOR REGION

TRAIN ORDERS, AUTHORITIES AND MESSAGES RECORD Jan 28 19 78

ORDER NUMBER	ADDRESS	BODY OF ORDER	SIGNATURES	BLOCKING DEVICES (IN RED INK)	OPERATOR'S INITIALS AND TIME OF REPETITION	COMPLETE TIME	COMPLETE INITIALS
92C	[illegible] 1523 [illegible]	[illegible] track [illegible]		[illegible]			
	Cpy Union Foreman [illegible] at Hook	Train Director		Penn	RCD [illegible]		
	The 2 track out of service between Hook and Phil [illegible] may be used with authority by foreman [illegible] Stat rules on the 2 track at Baldwin are not in effect		CCR		SH [illegible]	10[illegible]	Ch

APPENDIX D

ABBREVIATED INJURY SCALE

Sixteen passengers and eight crewmembers sustained AIS-1 injuries. One crewmember sustained AIS-2 injuries.

The Abbreviated Injury Scale (AIS) was developed by the Association for the Advancement of Automobile Medicine (formerly the American Association for Automotive Medicine) as a universal system for assessing impact injury severity. This system codes single injuries and is the foundation for methods to assess multiply injured patients.

The AIS severity codes are as follows:

AIS	Severity Code
1	minor
2	moderate
3	serious
4	severe
5	critical
6	maximum injury, virtually unsurvivable
9	unknown

The injury scores for this accident were coded according to the 1985 revision of the AIS.

APPENDIX E

INSTRUCTIONS FOR USE OF TRACK BARRICADES

2

Amtrak **ENGINEERING PRACTICE**

ORIGINAL ISSUE DATE	NUMBER
04/18/85	2005
REVISED DATE	
FILE NUMBER	
RECOMMENDED DATE 6/12/85	PAGE 1
APPROVED DATE 7/23/85	OF 2

TITLE

TRACK BARRICADES

SCOPE AND NATURE:

To provide a physical barrier to define work limits of a track out of service for track work.

SPECIAL MATERIAL:

Track Barricade, shown on MW Standard Plan No. 78A320A.
AMMS No. 02-285-04512

PROCEDURE:

Track barricades will be properly placed on track and locked after permission to occupy track is received. They will be removed before track is cleared. Permission to install or remove track barricades is not needed from block operators or train dispatchers. They will be placed such as to define the actual work limits. If properly applied, they will shunt the track circuit, however, they cannot be relied upon to provide a positive shunt. One track barricade will be placed at each end of work limits except they will not be used when standard rolling stock equipment is being used on the track out of service such as the TLS, undercutter, rail grinder, work trains, etcetera. When track gangs, such as surfacing gangs are working separately from where rolling stock is being used, track barricades will be used.

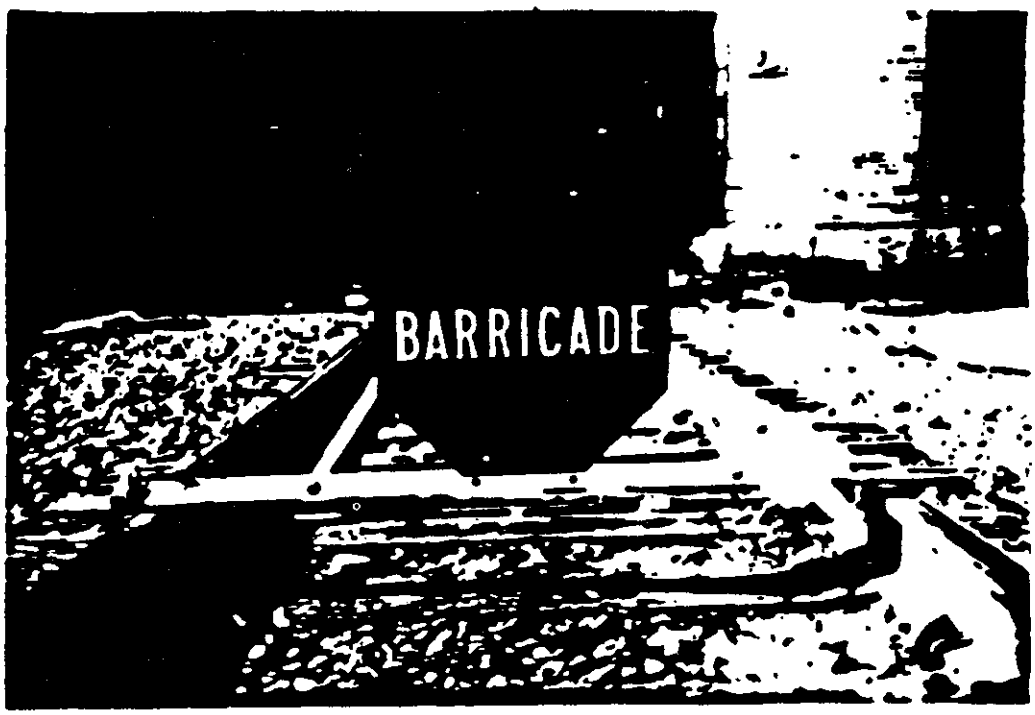
Track barricades will not be used within interlocking limits.

Track barricades, when removed from track, will not be left lying along right-of-way unless chained securely and locked to a fixed object.

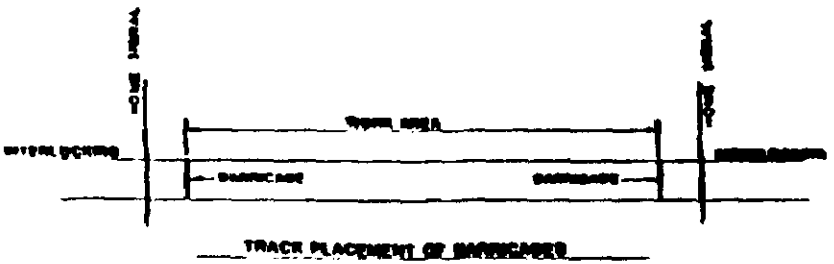
RESPONSIBILITY:

Track Foreman - Comply with Procedure
Track Supervisor - Comply with Procedure
District [redacted] - Comply with Procedure
Division [redacted] - Ensure Compliance with Procedure

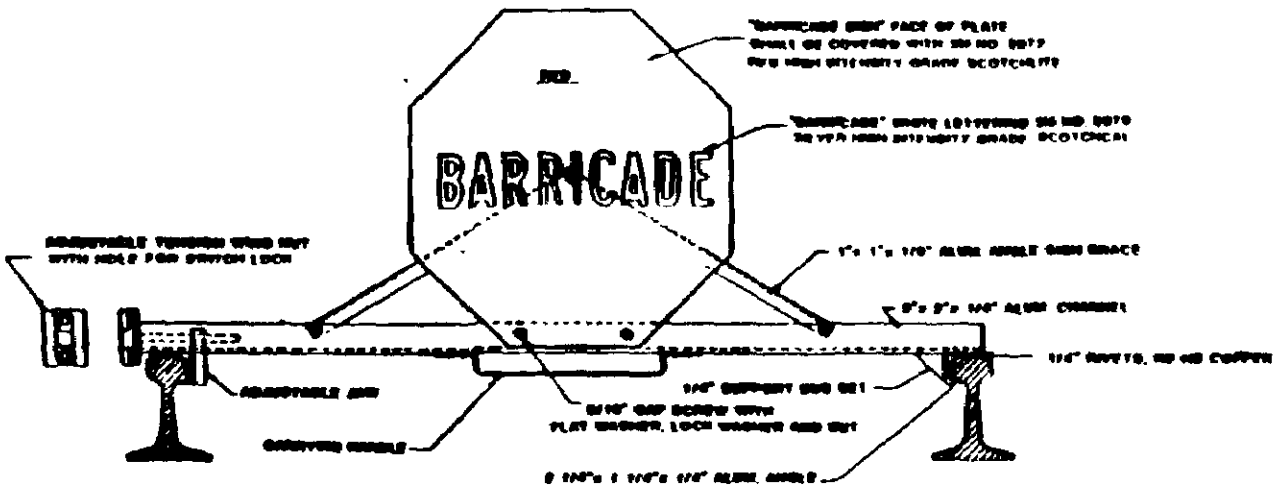
Amtrak ENGINEERING PRACTICE	ORIGINAL ISSUE DATE 4/18/85	NUMBER 2005
	REVISED DATE	
TITLE	FILE NUMBER	
TRACK BARRICADES	RECOMMENDED DATE	PAGE 2
	APPROVED DATE	OF 2



TYPICAL INSTALLATION



TRACK PLACEMENT OF BARRICADES



PLAN AND SECTION

NOTES

1. BARRICADES WILL NOT BE USED WHERE THERE IS A WORK TRAIN OR STANDARD RAILROAD SYSTEM IN THE TRACK AS IN THE CASE OF THE TLO, UNDERCUTTER, RAIL GRINDER, WORK TRAIN, ETC.
2. BARRICADES WILL NOT BE USED WITHIN SIGNALIZED LIMITS
3. BARRICADES HAVE ARMS NO. 99-000-00010

64

Amtrak AM78A320A

STANDARD

TEMPORARY TRACK BARRICADE

APRIL, 1988

APPENDIX F

EXCERPTS OF AMTRAK OPERATING RULES

MOVEMENT OF TRACK CARS

801 Track cars will be in charge of driver, governed by Operating Rules and Special Instructions applying to track cars and by the same Operating Rules and Special Instructions as apply to trains other than passenger trains, except as provided in Rules 801 to 830, inclusive

802 Foremen and others specified by the Chief Engineer must be qualified annually on the Operating Rules and physical characteristics of the territory over which they are to operate

Employees who are not qualified on the Operating Rules and physical characteristics may operate track cars only when working under the direct supervision of a qualified employee

803 Track cars will be designated by the prefix TC and last four (4) numerals, except Burro Crane will use the prefix BC, Highway Rail Car the prefix HRC, and Detector Car the prefix DC

804 Track cars must not be placed on the track at any time unless authorized by the Train Dispatcher, Operator, or Yardmaster who authorizes movements on such track

Track cars must not be left on the track unless protected

805 On tracks governed by Block Signal System Rules, track cars will operate with authority of Track Car Permit Form M in lieu of Train Orders

806 Blocking devices must be applied to all switch and signal levers leading to the affected route, and must be recorded by the Operators involved and the Train Dispatcher before Track Car Permit Form M is issued Train Dispatcher may then issue Track Car Permit Form M with applicable portions filled out in their entirety When block ahead is clear of other track cars, engines or trains the word "NONE" will be shown Operators are responsible for copying Track Car Permit Form M, and for their proper delivery

Train Dispatcher will require Operator(s) to repeat Track Car Permit Form M, before authorizing delivery to the TC-Driver or Foreman addressed All block stations involved in the track car movement must have a copy of the Track Car Permit Form M

A track car having received Track Car Permit Form M, to run "From" one point to another must not move in the reverse direction

A track car having received Track Car Permit Form M to occupy a track "between" designated points may move in either direction The Train Dispatcher must not authorize any following movements unless permission is received from the Foreman issued the "between" Track Car Permit Form M

807 Track Car Drivers must, when practicable, show Track Car Permit Form M to other occupants of the track car and they must read same

809 Track car movements entering interlocking limits must receive a proceed indication on all interlocking signals governing the route to be taken except the interlocking signal controlling movement into the block Clearance Permit Form C must be issued to authorize movement to pass this signal in stop position As prescribed by Rule 805, track car must

receive Track Car Permit Form M before entering Block Signal System territory

A multiple block Track Car Permit Form M, i e , one giving authority to move between three or more interlockings, may be issued only for the movement of a Track Geometry Car, Sperry Rail Car, or Passenger Type Highway Rail Car Before such authority is issued, intermediate interlocking signals must be displayed for the movement to be made, and approved blocking devices must be applied to all switch and signal levers for the entire route When so authorized, such equipment may proceed without stopping at intermediate interlocking signals displaying proceed indications

Track car movements must be reported clear of interlocking limits to the Operator controlling the interlocking

811 Track Car Driver must, as soon as practicable, report any delays which will prevent track car from arriving at destination prior to expiration of time limit

Prior to expiration of time limit, track car must be removed clear of the main track and Operator must be notified

812. If movement is required to clear the track at any point enroute, Track Car Permit Form M authorizing the use of track is annulled and a new Track Car Permit Form M must be issued for any further movement

813 Rules 550 to 563, inclusive, do not apply to track cars

814 Movements of track cars must be recorded in RED ink by the Train Dispatcher on the train sheet and by the Operator on the block sheet Operators must retain an office copy of Track Car Permit Form M

815 Rules 17 and 19 will not apply, but a white light to the front and a red light to the rear of each track car must be displayed by night, while passing through tunnels and when visibility is restricted

Highway Rail Cars must have headlights on bright at all times when on the rails

817 When it is known that the block in advance is clear, track cars may pass unlighted numbered fixed signals that are approach-lighted at normal speed without stopping Hand-operated switches in advance of such signals must not be passed over until it is ascertained that the route is properly lined

818 Track cars must be brought to a stop before proceeding over any highway crossing at grade An employee must be assigned to protect against highway traffic and must remain stationed at crossing until entire movement of track equipment has been completed over crossing

819 Track cars must not make trailing movements through semi-automatic switches or spring switches until such switches have been properly lined by hand

820. Unless otherwise provided, a train must not be permitted to follow a track car into the block except as authorized by Train Order which will specify Restricted Speed within the limits in which the track car is authorized to move

821 A track car operating with a Track Car Permit Form M indicating track car, engine or train ahead in the block must not exceed Restricted Speed and comply with Rule 828

PROTECTION FOR ON-TRACK MAINTENANCE EQUIPMENT

829 In the application of second paragraph of Rule 101, a Format W Train Order must be used when track is obstructed for maintenance, unless otherwise provided by Special Instructions

The Train Order will be addressed by name to the Foreman requesting use of the track and to the Operators controlling entrance to the track

829a Before the Train Order is made "complete," the Operator must apply approved blocking devices to all switch and signal levers leading to the affected route advising the Train Dispatcher when it is done using the abbreviation BDA and reporting the time and switch or signal levers by number This information must be noted in **RED** ink in the Train Dispatcher's train order book or train sheet and on the Operator's block sheet If, thereafter, it becomes necessary to remove the blocking device, the Operator must secure permission from the Train Dispatcher indicating the switch or signal lever by number

829b The Train Dispatcher will record in the train order book or train sheet and the Operator on the block sheet that the blocking device has been removed using the abbreviation BDR and the time recorded in **RED** ink

829c After the movement is completed, the Operator must immediately re-apply the blocking device or devices and advise the Train Dispatcher that they are re-applied

829d The Train Dispatcher and Operator must record the re-application in the same manner as required in the original application

829e When so equipped, the panel blocking device must be used in lieu of blocking switch and signal levers However, when the panel blocking device is used, it will be so indicated in **RED** ink by using the abbreviation PBDA or PBDR

829f. The Train Dispatcher or Operator must not permit additional equipment to enter the out-of-service limits unless authorized by the Foreman named in the Format W Train Order, and then only after delivering a copy of the Train Order to the person in charge of the additional equipment The person in charge of the additional equipment must also receive verbal or written authority from the Foreman named in the Train Order When written authority is used, it must include all pertinent information governing the movement of the additional equipment and must be signed by the Foreman named in the Train Order

829g Signal must not be displayed for movement into the portion of track taken out of service Clearance Permit Form C must be issued to authorize movement to pass the signal in Stop position

Block Signal System rules do not apply on portion of track taken out of service All movements will operate at Restricted Speed

829h The Foreman named in the Format W Train Order may admit additional equipment to the out-of-service limits from a point not controlled by the Train Dispatcher or Operator by showing or reading his copy of the Train Order to the person in charge of such equipment

TRAIN DISPATCHERS

313 Report to and receive their instructions from the General Superintendent or from such officer as he may designate They must be qualified on the physical characteristics of the railroad in their charge and with all General Orders Bulletin Orders General Notices and other instructions which affect their territory before assuming charge of their duties

A Train Dispatcher who has not performed service on a dispatching district during the previous 12 months must not accept assignment to such position without approval of the designated Division Officer

They will issue and record Train Orders in accordance with the rules They will issue such other instructions as may be required for the safe and efficient movement of trains and track cars Where the rules require Train Dispatchers to record the application of blocking devices they must insure that the blocking devices applied afford the necessary protection They must currently maintain the Record of Train Movements in ink They must provide necessary information to proper railroad officials and public safety authorities

They must report any violation of the Operating Rules and any irregularity relating to the movement of trains

They must keep informed of weather conditions that may affect the movement of trains

They must be conversant with the requirements of Special Instructions Governing Operation of Signals and Interlockings insofar as their duties are concerned

They will be conversant with the Electrical Operating Instructions insofar as their duties are concerned

They will operate electronic equipment which can assist in the prompt movement of trains

They must have available when being relieved a written transfer in the Record of Train Orders Authorities and Messages (AMT 22) listing all outstanding and unfulfilled Train Orders Plate Orders in effect authorities and messages along with the number of the last General Order Bulletin Order General Notice and other information relative to existing conditions The relieving Train Dispatcher must be assured that he understands the information contained in the transfer and will sign in the place required in the presence of the relieved Train Dispatcher

Upon assuming duty the Train Dispatcher must verify with the affected Operators that they are in possession of all Train Orders Plate Orders Track Car Permit Form Ms or other written directives which are in effect and addressed to or in care of their location

OPERATORS

914 Report to and receive their instructions from the General Superintendent or other designated officers Train Directors their Assistants and Levermen in the duties assigned them are also governed by these instructions

An Operator who has not performed service on a position during the previous 12 months must not accept assignment to such position without approval of the designated Division Officer

They must obey the instructions of the Train Dispatcher or Train Director and advise them immediately of any occurrence which may affect proper operation or safety of train movements They must comply with the instructions of officers of other departments on matters pertaining to those departments

They are responsible for the delivery of Train Orders and messages to the persons addressed They will arrange the use of blocks, tracks interlocking switches and signals for the prompt movement of trains in accordance with the Rules Train Orders, and Special Instructions They must currently maintain in ink the prescribed Station Record of Train Movements

They will observe passing trains in compliance with Rule 77 and report the improper display of marking devices

They must report the weather as required and in case of sudden changes such as high water storms or fog promptly advise the Train Dispatcher

They will operate hand-operated switches, movable bridges and other devices as required

They must pass necessary examinations and be qualified at a block or interlocking station before accepting an assignment for duty

They will operate power control boards and such other devices as directed by the Power Director

They must comply with the requirements of the current issue of Special Instructions Governing Operations of Signals and Interlockings

When approved Blocking Devices have been ordered 'Applied' by the Train Dispatcher they must not be removed unless authorized by the Train Dispatcher

The display of unauthorized publications the use of unauthorized appliances, as well as placing non-essential items on instrument cases or interlocking machine is prohibited

They must not absent themselves from duty until relieved and must notify the Train Dispatcher promptly should their relief fail to report at the prescribed time

They must complete the transfer portion of Station Record of Train Movement with all necessary information The relieving Operator must read this information aloud to Operator being relieved to insure complete understanding and sign this record in his presence

Upon assuming duty Operators must contact the Train Dispatcher and verify that they are in possession of all Train Orders, Plate Orders Track Car Permit Form Ms or other written directives which are in effect and addressed to, or in care of their location

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