

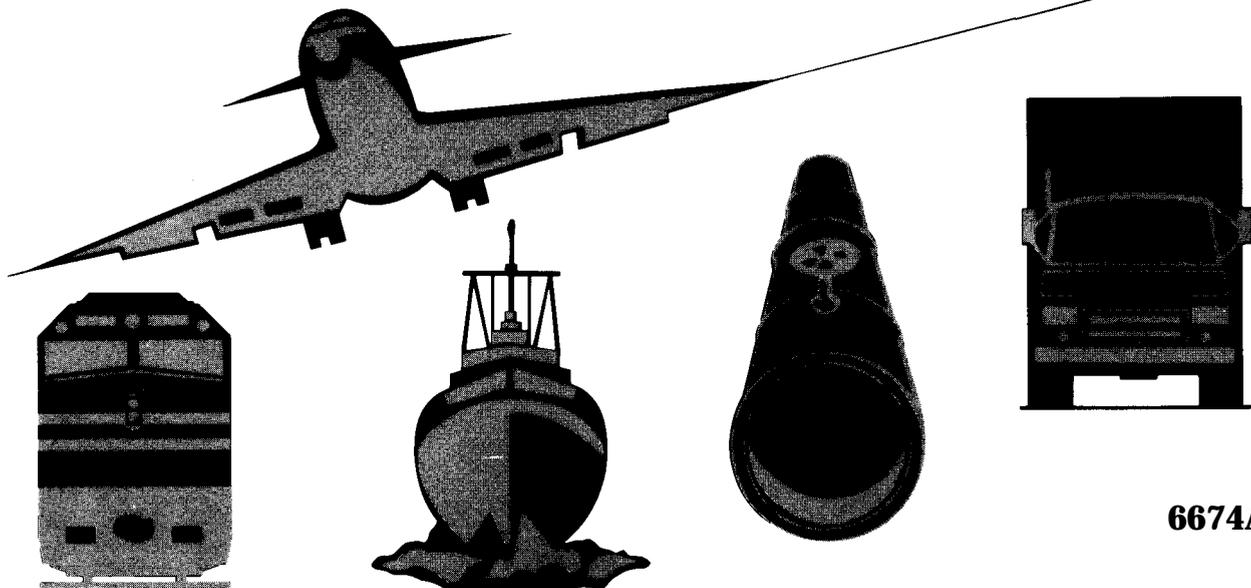
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NTSB/RAR-97/01

# **NATIONAL TRANSPORTATION SAFETY BOARD**

**Washington, D.C. 20594**

## **RAILROAD ACCIDENT REPORT**

**NEAR HEAD-ON COLLISION AND DERAILMENT OF  
TWO NEW JERSEY TRANSIT COMMUTER TRAINS  
NEAR SECAUCUS, NEW JERSEY  
FEBRUARY 9, 1996**



**6674A**

**Abstract:** This report explains the collision of two New Jersey Transit trains near Secaucus, New Jersey, on February 9, 1996. Three people were killed and 69 people were treated at area hospitals for minor to serious injuries sustained in this accident. The total estimated damage exceeded \$3.3 million.

From its investigation of this accident, the Safety Board identified the following safety issues: the medical condition of the engineer of train 1254, the adequacy of medical standards for locomotive engineers, and the adequacy of the response to the accident by New Jersey Transit train crewmembers. Based on its findings, the Safety Board made recommendations to the Federal Railroad Administration, the New Jersey Transit, the Association of American Railroads, the American Public Transit Association, the Brotherhood of Locomotive Engineers, and the United Transportation Union.

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**NATIONAL TRANSPORTATION  
SAFETY BOARD**

Washington, D.C. 20594

**RAILROAD ACCIDENT REPORT**

**Near Head-On Collision and Derailment of  
Two New Jersey Transit Commuter Trains  
Near Secaucus, New Jersey  
February 9, 1996**

**Adopted: March 25, 1997  
Notation 6674A**

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## EXECUTIVE SUMMARY

On February 9, 1996, about 8:40 a.m., eastbound New Jersey Transit (NJT) commuter train 1254 collided nearly head-on with westbound NJT commuter train 1107 near Secaucus, New Jersey. About 400 passengers were on the two trains. The engineers on both trains and one passenger riding on train 1254 were killed in the collision.

The National Transportation Safety Board determines that the probable cause of New Jersey Transit (NJT) train 1254 proceeding through a stop indication and striking another NJT commuter train was the failure of the train 1254 engineer to perceive correctly a red signal aspect because of his diabetic eye disease and resulting color vision deficiency, which he failed to report to New Jersey Transit during annual medical examinations. Contributing to the accident was the contract physician's use of an eye

examination not intended to measure color discrimination.

The major safety issues discussed in this report are the medical condition of the engineer of train 1254, the adequacy of medical standards for locomotive engineers, and the adequacy of the NJT train crewmembers' response to the accident. In addition, the Safety Board examines crashworthiness of the trains and the response effort of emergency personnel.

As a result of its investigation of this accident, the Safety Board makes recommendations to the Federal Railroad Administration, the New Jersey Transit, the Association of American Railroads, the American Public Transit Association, the Brotherhood of Locomotive Engineers, and the United Transportation Union.

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# INVESTIGATION

## Accident Synopsis

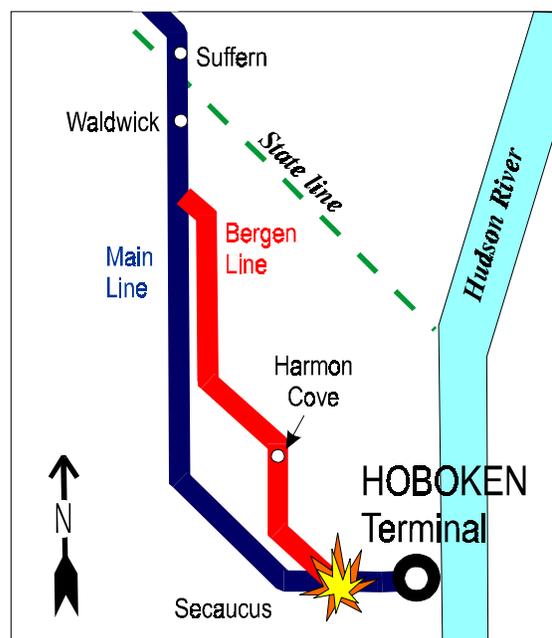
On February 9, 1996, about 8:40 a.m., eastbound New Jersey Transit (NJT) commuter train 1254 ran a stop signal at an interlocking<sup>1</sup> near Secaucus, New Jersey (figure 1), and collided nearly head-on with westbound NJT commuter train 1107. About 400 passengers were on the two trains. The engineers on both trains and one passenger riding on train 1254 were killed in the collision.

## Accident Narrative

According to New Jersey Transit (NJT) officials, signal problems north of Suffern, New York, on the evening of February 8, 1996, resulted in a disruption of rail operations the following morning.<sup>2</sup> To accommodate a backlog of passengers on the more heavily traveled portions of the line from Suffern, New York, to Hoboken, New Jersey, the NJT's Hoboken control center provided additional service. To staff one of the extra trains, the chief road foreman asked a train crew who had just completed their regular shift at 7:28 a.m. if they would be interested in operating a train from Waldwick to Hoboken. The crew accepted the assignment. The road foreman later said that none of the crewmembers acted or appeared tired when he offered them the extra run.

This added service, NJT commuter train 1254, consisting of a diesel locomotive unit and five passenger cars, departed Waldwick station at 8:03 a.m. Its three-man crew comprised an engineer, a conductor, and an assistant conduc-

tor. Shortly after Waldwick, train 1254 was lined to Bergen County line track No. 2. The conductor for train 1254 later stated that he took no exception to the engineer's train handling, including his braking, his responses to communication signals, and his positioning of the train at stations. Event recorder data indicate that the engineer was operating the train in compliance with applicable speed restrictions during the trip.



**Figure 1—NJT train 1254 originated at Waldwick and was en route to Hoboken via the Bergen Line.**

Meanwhile, NJT commuter train 1107, consisting of a diesel locomotive unit and six passenger cars, left Hoboken at 8:31 a.m. en route to Suffern. The train had a crew of three, including an engineer, a conductor, and an assistant conductor, and was carrying about 125 passengers. Two NJT engineers who were deadheading to other assignments were on board train 1107. Neither the off-duty NJT engineers nor the conductor and assistant conductor took exception to the engineer's train handling.

<sup>1</sup> An interlocking is an arrangement of signals and signal appliances interconnected such that operation and/or movement of the components must succeed each other in proper sequence.

<sup>2</sup> The events in this narrative are reconstructed using recorder data and testimony from NJT personnel and train passengers. All times are eastern standard time.

Hoboken tower personnel who were controlling area signal operations the morning of February 9 said that train 1254 had not “hit the bell”<sup>3</sup> at the approach signal to the West End interlocking when train 1107 departed Hoboken. The tower therefore “held” signal 28E-1; that is, it maintained a stop indication at the signal, in case train 1254 approached the interlocking before train 1107 cleared it.

When train 1254 left Harmon Cove station about 8:33 a.m., it was carrying about 275 passengers. The engineer accelerated to 53 mph. According to tower personnel, as train 1254 neared the West End interlocking, the approach signal (R-6) would have been displaying a *Medium Approach* signal and the signal at the interlocking (28E-1) would have been displaying a stop indication. Event recorder data indicate that when train 1254 passed the approach signal, it was traveling about 34 mph and its throttle was in idle, meaning it was coasting. The train continued slowing until about 71 feet before 28E-1, at which point the engineer applied the throttle and train 1254 accelerated past the *Stop* signal traveling about 20 mph. Shortly thereafter, train 1254 went into emergency braking. It continued onto the Main line track No. 1. At the same time, westbound train 1107, operating on a clear signal on Main line track No. 1, entered the interlocking traveling 53 mph. Train 1254 was moving about 18 mph when the collision occurred about 165 feet past signal 28E-1 (figure 2).

Train 1254 had been operating in the push configuration with the locomotive in the rear and the engineer controlling the train from a cab car in the lead. Train 1107 had been operating in the pull mode with the engineer controlling the train from the locomotive in the lead. The right corner of train 1254’s cab car struck the right corner of train 1107’s locomotive and was sheared off. The conductor of train 1254 later stated that he had been collecting tickets and walking in the direction of the engineer’s compartment when the train began “ripping apart.”

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**Figure 2—Accident layout. Train 1254 was in the push configuration with the locomotive in the rear and the engineer controlling the train from the cab car in the front. Train 1107 was in the pull configuration with the engineer operating the train from the locomotive in the front.**

The cab car derailed and came to rest at a 45-degree tilt to the track. The locomotive and the first five trailing cars of train 1107 derailed (figure 3).

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<sup>3</sup> As trains pass given signals in the system, a bell rings to alert tower personnel controlling the switches and signals.



Figure 3—Accident site (looking west). Unit 5120 is the last car in the train 1107 consist. Derailed unit at right is the cab car of train 1254. Photograph courtesy of Jim Mardigian.

At 8:40 a.m., the engineer of an NJT commuter train that was traveling east on Main line track No. 2 stopped his train and radioed the Hoboken terminal control center about the collision. The NJT reported the accident to the Secaucus Police Department, which in turn notified the Jersey City Emergency Medical Services (EMS) at 8:45 a.m. The first EMS unit arrived on-scene about 9 a.m. and had established a triage area by 9:08 a.m. All injured people had been removed from the scene by 10:43 a.m. (Additional information about the response effort appears in the *Survival Fac-*

*tors* section of this report.) The engineer of train 1107, the engineer of train 1254, and a passenger in the first car of train 1254 suffered fatal injuries. A total of 69 casualties were transported to area hospitals for treatment.

## Injuries

Table 1 is based on the injury criteria (49 *Code of Federal Regulations [CFR] 830.2*) of the International Civil Aviation Organization, which the Safety Board uses in accident reports for all transportation modes.

Table 1 — Injuries in the Secaucus, New Jersey, Train Accident

Injury Type	Train 1254 Crew	Train 1107 Crew	Passengers	Emergency Response	Total
FATAL	1	1	1	0	3
SERIOUS	1	0	7	2	10
MINOR	0	0	148	0	148
NONE	1	2	244	0	247
TOTAL	3	3	400	2	408

## Damages

The NJT provided the damage estimates shown in table 2. A detailed description of damages appears in the *Wreckage* section of this report.

**Table 2 — Damage Estimates**

Equipment - Cars	\$1,128,624
Equipment - Locomotives	2,200,000
Track Repair	50,000
Wreckage Removal	50,000
TOTAL	\$3,328,624

## Personnel Information

Safety Board staff reviewed the personnel files and work records of all crewmembers involved in the accident. The job history and medical information for the train 1254 engineer follows. Information about the engineer of train 1107 appears in *appendix B*.

**General**—The 59-year-old engineer of train 1254 had been employed by NJT and its predecessors for 40 years. He was promoted to a locomotive engineer on January 4, 1961. He had passed his last rules examination on February 21, 1995. He was recertified for his position as a locomotive engineer on March 24, 1994, receiving an operating evaluation rating of 3.34, or

“Standard” on a scale of 5, and an efficiency test rating of 91.5 percent. During the 3 years before the accident, company officials had made 242 announced and unannounced observations of him for rules compliance as part of the NJT’s normal operating procedures. (See *Operations* section in this report.) Of the 242 compliance checks, 56 involved adhering to signal indications. His compliance rate overall was 97.52 percent. Of the six infractions noted, five were minor offenses resulting in verbal reprimands; none of the six infractions involved failure to comply with signal indications. Table 3 shows all disciplinary actions listed in the engineer’s personnel records for the period between 1983 and 1993.

Based on his seniority, the engineer had been able to select the duty assignment of his choice. Since 1992, he had elected to work an overnight split shift as allowed by the Hours of Service Act, as revised (49 *CFR* 228). Monday through Friday, he reported for duty at 6:11 p.m. at Hoboken terminal, completed five train movements, and then marked off duty at 12:58 a.m. at Suffern for a rest period of 4 hours and 47 minutes. He then went back on duty at Suffern at 5:44 a.m. and operated a train back to Hoboken terminal, where he went off duty at 7:28 a.m. According to other crewmembers who worked this assignment, the engineer normally would rest in the coaches at Suffern for about 4½ hours before reporting back on duty.

**Table 3—Disciplinary Actions Against the Engineer of Train 1254**

Date	Action	Infraction
1-26-83	30 Day Suspension	Derailed engine in yard
9-26-85	Reprimand	Reported late for duty
6-2-86	45 Day Suspension	Passed stop signal
7-10-87	10 Day Suspension	Passed passenger stop
7-20-89	Reprimand	Reported late for duty
12-28-89	30 Day Suspension	Passed stop signal

**Duty/Rest Schedule**—The Safety Board reconstructed the engineer’s activities during the 3 days before the accident using NJT records and statements from his co-workers and his spouse (table 4). The conductor of train 1254 had worked the split shift with the engineer off and on for almost 2 years. He testified that although he and the engineer never really talked about their daytime routines, he thought that the engineer normally slept in the afternoon. He said that the engineer never appeared to have any problems getting to sleep and staying asleep during the break in their shift. Further, the conductor said that during the years that they had worked together, the engineer had never complained of being tired and had never appeared tired, including the night before and the morning of the accident.

The engineer’s wife was employed outside the home and usually left for her job about 6:30 a.m., before he returned from work. On weekdays, they typically saw each other only during the late afternoon. She said that to her knowledge, he spent his off-duty hours around the house watching television, sleeping, or at a nearby marina working on his boat.

**Other Activities**—In her statement to the Safety Board, the engineer's spouse said that he did not work a second job or have a business. Investigators determined that the engineer reportedly had owned a Staten Island, New York, company, JDC Enterprise, during the 10 years before the accident. The business, which he operated with one of his sons, was engaged in rebuilding automotive and marine starters and alternators. During his time off duty from NJT, he was involved in all aspects of the business, including taking orders and making deliveries to customers. Owners and managers of area auto parts stores and marinas characterized him as an honest and reliable businessman.

**General Health**—The engineer's spouse reported that he was “never sick,” that he had not suffered from any illnesses or unusual life events in recent months, and that he was physically and mentally in good health at the time of the accident. He had not suffered any

**Table 4—72-Hour Work/Rest History of the Train 1254 Engineer**

Date	Activity
Feb 6	Daytime activity unknown. After wife returned home with carryout, he ate dinner about 5 p.m. and left for work at 5:20 p.m. according to his routine.
Feb 7	Daytime activity unknown. Wife found him sleeping on couch when she returned home. He ate dinner and left for work at 5:20 p.m.
Feb 8	Daytime activity unknown. Wife found him asleep when she returned home at 3:15 p.m. She woke him at 4:50 p.m., whereupon he ate dinner and left for work at 5:20 p.m. Crewmembers stated that the engineer reported on schedule at 6:11 p.m.
Feb 9	Marked off duty on schedule at 12:58 a.m. at Suffern yard. Slept about 4.5 hours in a passenger coach of his train. At 5:30 a.m., another crewmember woke him and he reported for duty on time at 5:44 a.m. He operated his train to Hoboken, arriving at 7:13 a.m., and went off duty. He accepted an overtime assignment and dead-headed to Waldwick, arriving at 7:57 a.m. He departed Waldwick operating train 1254 at 8:03 a.m. When the accident occurred at 8:40 a.m., he had been in an overtime status 1 hour and 12 minutes.

financial or personal problems and had indicated to her that he planned to work until age 65 or older and then retire to Florida. According to his spouse, he did not drink alcoholic beverages or smoke tobacco products, and did not use illicit drugs. She said that he took a pill twice daily for diabetes, but otherwise kept his medical condition to himself. She said that he had worn bifocal glasses for about 2 years and that she had not noticed a significant change in his hearing or vision. She did not know if he had any color perception problems. She said that he was due for a medical examination at the time of the accident.

**Medical History**—NJT medical examination records indicate that the engineer was

medically disqualified from his duties for 2 weeks in 1987 after sugar was detected in his urine during an annual physical examination. After visiting his personal physician, receiving prescribed medication, modifying his diet, and lowering his blood sugar, he returned to the NJT physician, who determined that he was medically qualified for duty.

NJT records show that the engineer received his last company physical on February 6, 1995, and was found to be medically qualified for duty. His next NJT physical was due during February, 1996. NJT records indicate that he received a random drug/alcohol test, which checks only for the presence of illicit or disqualifying drugs, on January 24, 1996, 3 weeks before the accident. The test was negative.

The engineer's NJT medical file contains no record indicating that he had diabetes. As part of the NJT annual examination, employees are required to fill out a medical history form that has 40 "yes" or "no" questions about present and past medical conditions. Since 1985, the engineer had answered "no" to the following questions on every NJT medical examination, including his most recent physical in 1995.

Since your last examination in the Medical Department:

- Have you been examined or treated by any physician or other practitioner?
- Are you taking any medicine?
- Have you had diabetes?
- Have you taken any medication in the past 60 days? If so, what and why?

The Safety Board subpoenaed and reviewed the engineer's personal medical records and interviewed his personal physician. The doctor stated that the engineer had been a non-insulin-dependent (type II) diabetic for 19 years and, as a result, suffered from peripheral vascular disease, which affects blood vessels, especially in the extremities. She said that she had counseled him about his condition and treated him

with various oral medications to reduce high blood sugar since 1982, and he had been essentially asymptomatic until 1987. In 1987 and 1988, she had prescribed Diabinese for elevated blood sugar.

During the 6-year period between 1988 and 1994, the engineer did not visit any physician. In 1994, he saw his personal doctor with complaints of weakness, numbness in his toes, a foot lesion that would not heal, and a persistent cold, which he attributed to working two jobs. Laboratory tests indicated elevated blood sugar levels, and the doctor prescribed Glynase to control his blood sugar and other medications. At that time, she referred him to an ophthalmologist for an eye examination.

During a 1995 examination conducted by his personal physician, the engineer had a very high blood sugar level for which the doctor prescribed Glucotrol. She learned that he had been seeing an eye surgeon and had undergone laser surgery treatments in both eyes for diabetic retinopathy, an eye disease that damages the blood vessels of the retina, frequently causing severe and permanent vision loss.

**Visual Acuity**—Records of the eye examination given during the engineer's latest company physical in February 1995 indicate that his visual acuity was 20/40, corrected to 20/20, and that corrective lenses were required for reading and distant vision.

The Safety Board obtained copies of the eye surgeon's medical records. An April 1995 (Snellen<sup>4</sup>) examination indicates that the engineer had 20/40 vision with correction in his

right eye and no central vision in his left eye.<sup>5</sup> Documents show that since April 1995, the eye

<sup>4</sup> Hermann Snellen (1834-1908), a Dutch ophthalmologist, developed the type of charts with lines of progressively smaller letters that are now universally used as a simple test of visual acuity.

<sup>5</sup> As opposed to peripheral vision, central vision is that portion of the visual field closest to the center (visual axis), where the density of (primarily color) vision receptors is

Table 5— Dvorine PIP Test Classifications

Number of Plates Missed	Degree of Color-Blindness	Expected Percentages	Degree of Handicap
0 to 2	Normal	89.5	No handicap, Acceptable
3 to 4	Borderline	3.0	Mild handicap. May improve score on retest. Acceptable
5 to 11	Moderate	2.0	Moderate handicap. May be employed in occupations where critical color judgment is not essential. Not acceptable for civil aviation.
12 to 14	Severe	5.5	A definite handicap and hazard to industrial and military occupations. Not acceptable for civil aviation.

surgeon had treated the engineer for diabetic retinopathy using a combination of focal, grid, and panretinal photocoagulation<sup>6</sup> laser eye surgeries as the engineer's vision deteriorated. By December 1995, he had 20/400 vision with correction in the left eye, and 20/70 with correction in the right eye.<sup>7</sup> On January 19, 1996, he had visited the eye doctor to report that he had experienced "smoke" in his right eye for 2 days. On January 26, 1996, 2 weeks before the accident, his visual acuity remained unchanged, and he underwent additional panretinal photocoagulation laser surgery to his right eye. He had not had a follow-up examination with his personal physician before the accident occurred.

**Color Vision**—The only records containing information about the engineer's color vision were the NJT annual medical examination files. According to the engineer's certifying

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highest in the retina, and where form and color vision are most acute. Generally refers to at least the central 5 degrees of the visual field.

<sup>6</sup> A treatment making hundreds of small laser burns away from the center of the retina, shrinking abnormal blood vessels. Loss of peripheral vision results, and loss of color and night vision is not uncommon.

<sup>7</sup> That is to say, while wearing prescription lenses, the train 1254 engineer had to be within 20 feet of a reference point to identify what a person with normal (20/20) vision could discern from 400 feet or 70 feet (the engineer's left eye and right eye, respectively).

NJT physician, trained personnel administer the Dvorine Pseudo-Isochromatic Plates (PIP) test in an examination room lighted with overhead fluorescent (cool white) lamps. Investigators examined the Dvorine PIP test book used to test the engineer's color vision and found the book to be in good condition.

In the Dvorine PIP test that was administered to the engineer, the patient is shown a demonstration plate having a red number on a blue background and asked to identify it from a distance of 30 inches. The person is then asked to call out numbers on 14 other plates having different color combinations. The testing instructions contain the chart shown in table 5 for estimating the degree of color vision defect. (*Appendix C* contains a copy of the complete testing protocol.)

The engineer had been tested in this manner annually by the same NJT contract physician since at least 1985. Between 1985 and 1993, he missed none of the Dvorine plates. In 1994, he missed 2 of 15 plates. During his February 1995 test, he missed 6 of the 15 plates and was classified as having a moderate color vision handicap. The physician said that because of the number of plates that the engineer missed, he then gave him the Dvorine Nomenclature Test to further evaluate his color vision. The nomenclature test involves having the patient identify colors as the

tester rotates an eight-color disk. The testing protocol states that the nomenclature test is not a test of color discrimination ability, stating "...many color blind individuals learn to name the colors correctly by their brightness instead of their hue...."

According to the physician, when the engineer successfully identified the colors presented in the Dvorine nomenclature test, he medically certified him for duty.

The Safety Board consulted a color vision expert from the Federal Aviation Administration's Civil Aeromedical Institute. His report states that the Dvorine PIP Test is a highly valid and reliable test for differentiating normal color vision from any color vision deficiency, including the type that can occur due to advanced diabetic retinopathy and other causes.

**Driver History**—Safety Board investigators examined New York and New Jersey driver and accident records to determine if the engineer had any traffic violations or had been involved in any motor vehicle accidents where he lived or worked. His New York driving record contained no record of traffic violations. Jersey City (New Jersey) Police Department records indicate that on December 9, 1995, the engineer had been involved in a collision in which the engineer failed to negotiate a right-hand curve in the road, skidded, and struck a vehicle traveling in the opposite direction in the curve. The police investigators did not charge the engineer with a violation.

## Train Information

Both trains were configured for push/pull service, which allows trains to make round trips without repositioning the locomotive unit. A locomotive is at one end and a control (cab) car is at the other end of the consist. The locomotive provides the power, which the engineer controls either directly from the locomotive or remotely from the cab car. When the engineer operates from the locomotive, the train is in the pull

mode; when he operates from the cab car, the train is in the push mode.

**Train 1254**—Eastbound train 1254 had been operating in the push configuration with the locomotive unit in the rear and the operator controlling the train from a cab car in the lead. Front to back, the 6-unit consist included cab car 5146, coach cars 1760, 1603, 1738, and 1728, and locomotive unit NJT 4110 (a GPH40 model). During the on-site postaccident examination, Safety Board investigators found that the controller mechanism had been ripped out and was on the ground under derailed equipment. Investigators noted that the automatic brake handle was in the emergency position, the pilot valve was cut in, and the lock mechanism was intact, although its key was missing. The alerter mechanism had been ripped out and was among debris inside the front of the cab car.

**Train 1107**—Westbound train 1107 was in the "pull" configuration with the operator running the train from a locomotive in the lead. Front to back, the 7-unit consist included locomotive unit NJT 4148, coach cars 5712, 5739, 5708, 5735, and 5815, and cab car 5120. During the on-scene postaccident inspection, investigators noted that the throttle was in the number 8 position, the automatic brake valve was in the release position, the reverser was in the forward position, the independent brake valve handle was on the floor, and the engine run switch was in the run position.

Safety Board investigators examined the mechanical records, which indicate that all FRA-required inspections and tests had been conducted on the accident equipment. Maintenance records disclose only routine maintenance patterns and no recurring problems or trends.

## Track

The accident occurred on the NJT railroad at milepost (MP) 2.8 within the limits of the West End interlocking. The Bergen County line connects to the West End interlocking via Bergen Junction interlocking (MP 3.3).

At the accident site, the Main line track grade has a 0.52 percent descent from east to west. The maximum allowable speed on the Main line is 60 mph. The Bergen County line track grade has a 0.72 percent ascent from west to east. The maximum allowable speed of this section of the Bergen County line is 60 mph; however, the proximity of signals limit the operating speed to medium, or 30 mph. The two Main line tracks merge at a right-hand switch. Inspection of the switch disclosed no defects. Investigators observed sand on the rail from the locomotive's lead axle to a point 47 feet 3 inches behind train 1254, a distance of 108 feet.<sup>8</sup>

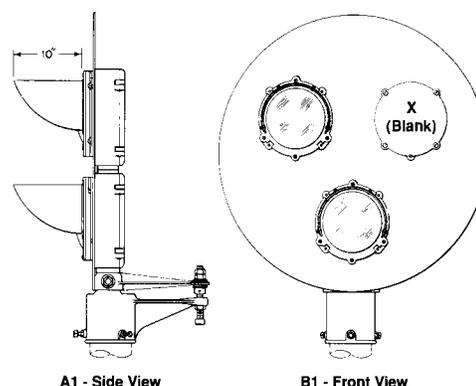
According to NJT officials, the tracks in the collision area receive a walking inspection twice a week. Track inspection records for the 3 months before the accident, including the last inspection on February 5, 1996, indicate that no anomalies had been detected in the derailment area. Geometry car inspections of the Main line track No. 1 and the Bergen County line track No. 2 in the derailment area on October 2, 1995, indicate no exceptions were taken. The most recent detector car examination on December 12, 1995, indicates no defects were found.

## Signal

The Main line has an automatic block signal (ABS) system, meaning train movement is controlled by the circuitry in the rail and that each of the two Main line tracks is signaled in one direction with signals that automatically indicate track conditions ahead. The Bergen County line has a traffic control signal system, meaning train movement is controlled by the tower personnel (at Hoboken) and the two tracks are signaled for movement in either direction. The Bergen Junction interlocking has search light-type signals that govern movements in both directions through the interlocking.

<sup>8</sup> The emergency braking system includes a box of sand, which is forced through a hose over the wheels and onto the rail whenever the train is placed in emergency braking. The dumped sand allows for increased traction and therefore better stopping distances.

Signal 28E-1 is a pole-mounted, long-range color-light-type device having three heads arrayed vertically. The top head has one lens, which is always illuminated red, and the two lower heads have two "active" lenses, yellow and red, which are illuminated depending on the signal indication. An enlargement of the lower head is below.

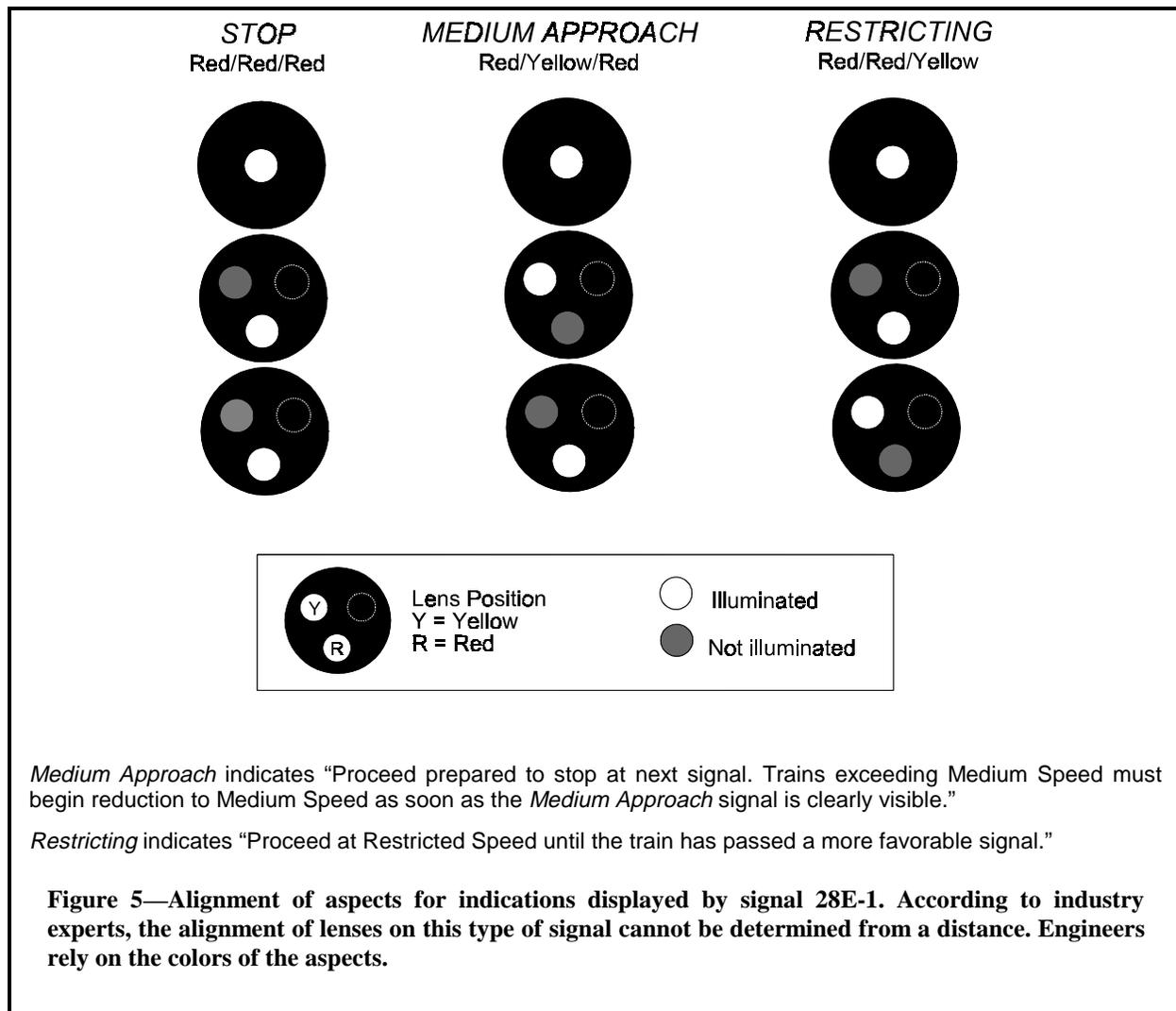


As manufactured, this model of signal head has three lenses: green at upper right, yellow at upper left, and red at lower middle. However, a carrier using two-aspect combinations in its signal system, such as NJT, can order the signal head with a blank lens.

Figure 4—Type of light unit at Signal 28E-1.

The three main tracks comprising the West End interlocking have Transcontrol color light signals (figures 4 and 5), General Railway Signal (GRS) Company model 5G electric switch machines, and 100 Hz phase selective track circuits.

The initial postaccident investigation disclosed that all signal housings had been properly locked, sealed, and protected against tampering until the Safety Board could examine the signals in the accident area. Investigators documented the position of the vital relays, including the date they were last tested. They took ground readings at all locations to determine whether a

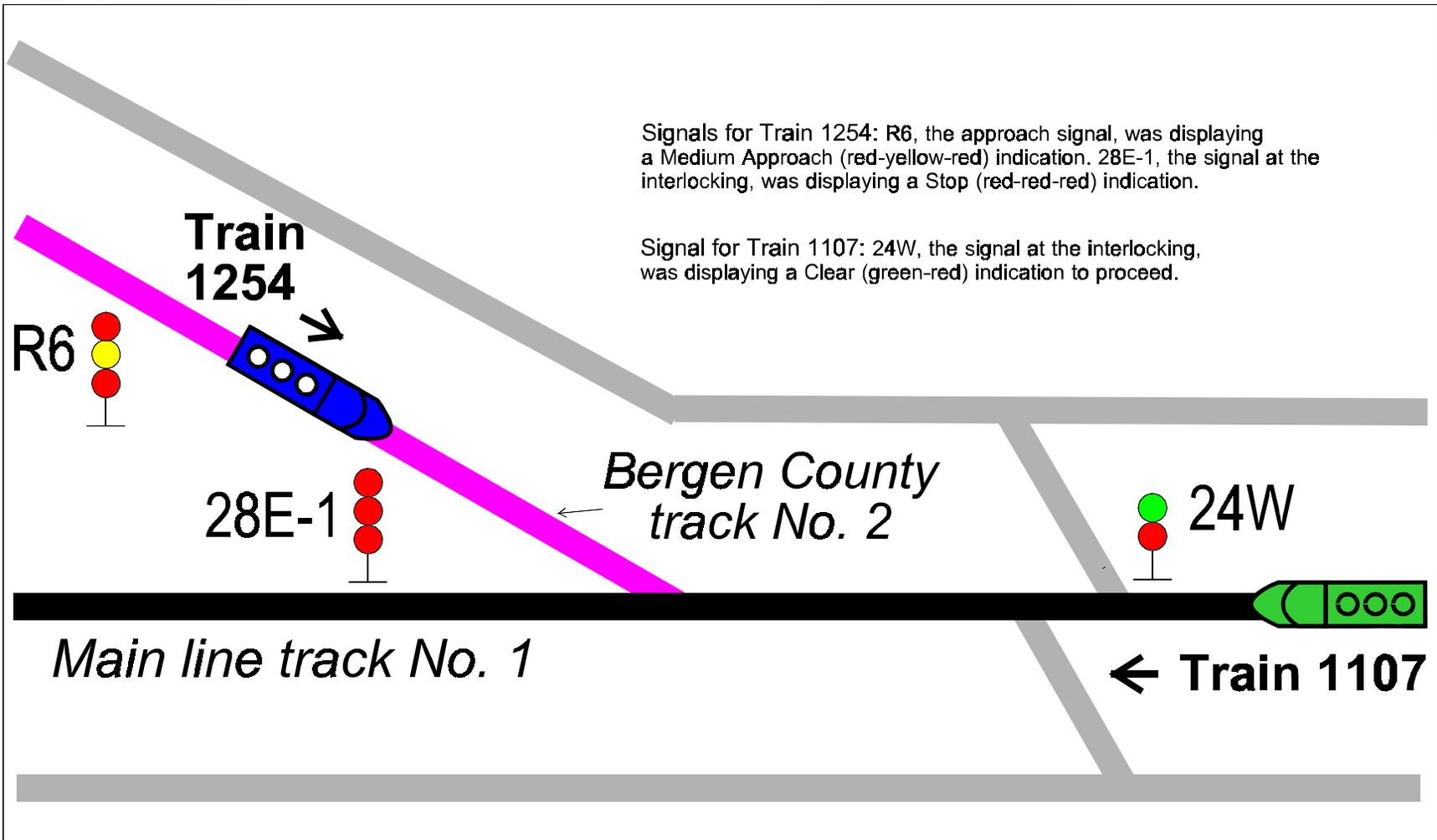


ground could have caused the false energizing of a signal circuit. The position of certain relays and illumination of certain lights on the local control panel (LCP)<sup>9</sup> at the central instrument location (CIL) at the West End interlock

ing indicated that switches Nos. 37, 39, and 49 had been lined and locked in position and that signal 24W had been displaying an indication for a westbound train to proceed on track No. 1 (figure 6).

Safety Board investigators had all lamps illuminated at signals R6, 28E-1, and 24W, and recorded their voltages. No signal lamps were burned-out. After inspecting the lamps on scene, investigators had them removed and sent to the Safety Board's Washington, D.C., laboratory for further analysis and testing. Safety Board metallurgists inspected a total of 14 signal lamps and found that the filaments in all bulbs were intact, appeared to be in working order, and showed no evidence of damage, deformation, or separation.

<sup>9</sup> The 28 east stick relay (28ESR) was energized and the 28 west stick relay (28WSR) was de-energized. According to West End Signal plans, this indicates that the route had been established for westbound movement.



On February 11, 1996, investigators conducted “locking” tests of the electrical circuits to ensure that the signals and signal appliances, such as switches, operated properly, that is, did not change within the prescribed relay time interval. Investigators tested the relays, meggered all cables, and verified all track circuits in the routes. All tests revealed that the signal system functioned as designed, in accordance with FRA requirements.

The NJT *Trouble Desk Logbook* indicates that the number of failures at the West End interlocking and the Bergen Junction interlocking had been 92 and 47, respectively, during the 2-year period before the accident. The failures included such routine signal system problems as burned out bulbs, broken rails, blown fuses, and defective relays, and no defects that could have resulted in a train receiving “a more favorable signal aspect than intended,” meaning any signal indication other than a *Stop* indication.

## Operations Information

**General**—Train movement over this territory is governed by the *Northeast Operating Rules Advisory Committee (NORAC) Operating Rules*, fifth edition, effective January 1, 1995. At the time of the accident, train and engine service employees were also governed by *New Jersey Transit Rail Operations Timetable No. 9 and Special Instructions in General Order (GO) 902*, effective 12:01 a.m., January 1, 1996 (NJT *Timetable No. 9*); *Hoboken Division Bulletin Order 9-H-S203*, effective 12:01 a.m. February 3, 1996; *Air Brake and Train Handling Rules and Instructions*, effective June 1, 1991; and *Hoboken Division Employee Train Schedules*, effective 2:01 a.m. on November 12, 1995.

The Main line train dispatcher at the Hoboken terminal is responsible for all train movements between the Bergen Junction interlocking and Port Jervis, New York, which includes the Main line, the Bergen County line, the Pascack Valley line, and the Southern Tier line. The Main line dispatcher also controls the interlockings on the Bergen County line and the Main line.

**Employee Oversight**—Title 49 *CFR* Part 240 prescribes Federal safety requirements for the eligibility, training, testing, certification, and monitoring of all locomotive engineers. At a minimum, railroad companies are required to give locomotive engineers at least one unannounced operations test each calendar year. Before this accident, the NJT policy was to have supervisors or other testing personnel go to outlying areas, such as Suffern, at least three times a week to observe crews for rules compliance. Records show that since January 16, 1996, the NJT made six unannounced observations of the train 1254 engineer’s operating procedures, including four unannounced speed compliance tests. The NJT made the most recent speed compliance checks of the train 1254 engineer on January 25, 1996, 15 days before the accident. The first test, a *Limited Clear*, was at 6:33 a.m.; the second test, a *Slow Approach*, was at 7:10 a.m. The engineer had been in compliance with all rules on which he was observed and tested. Since this accident, the NJT has increased the number of visits by testing personnel to Suffern to five a week.

## Meteorological Information

Witnesses stated that the weather was clear and sunny. A February 9, 1996, report from the Newark, New Jersey, weather radar station indicates at 8:50 a.m. the temperature was 42 degrees Fahrenheit with ceiling of 4,100 feet and broken cloud cover. Visibility was 15 miles.

## Medical and Pathological Information

**Fatalities**—Citing religious reasons,<sup>10</sup> the family of the fatally injured passenger asked that an autopsy not be performed on him, therefore the type and scope of his internal injuries are unknown. The examiner’s report shows that he sustained a 1-inch laceration on his scalp, an

<sup>10</sup> 49 USC (United States Code) 1134 (f)(1) states, in part, “...local law protecting religious beliefs related to autopsies shall be observed to the extent consistent with the needs of the accident investigation.”

abrasion on his forehead, a contusion on his right knee, and an abrasion on his left leg.

The engineer of train 1107 was killed at impact. He sustained massive cranio-facial, cervical and thoracic injuries with traumatic amputation of the right arm.

The train 1254 engineer suffered multiple blunt force injuries of the head and face with multiple skull fractures; blunt force trauma of the anterior neck with a fracture of the thyroid cartilage; fracture and dislocation of the right sternoclavicular joint; blunt force injury of the abdomen with a laceration of the abdominal aorta, spleen, and associated hemoperitoneum; fracture of the right femur and right patella; and, multiple superficial abrasions, lacerations, and contusions.

***Injury Sources***—Pathology photographs taken during the engineer’s autopsy show a scalp laceration with a circular serrated pattern. Safety Board investigators and personnel from the Armed Force Institute of Pathology (AFIP) examined debris in the interior of cab car 5146 and an exemplar cab car in an attempt to determine possible sources of injury. Two possible sources of injury were identified during these examinations: the windshield control knob and the brake handle.

Emergency medical personnel triaged about 400 passengers and treated 160 of them on scene. Sixty-nine passengers and crewmembers were transported to local hospitals for treatment of minor to serious injuries, including contusions, strains, abrasions, lacerations, and fractures. Passengers surveyed stated that they had been injured by striking interior surfaces, being thrown into seatbacks and the aisles, striking other passengers, or being struck by debris.

***Toxicological Testing***—In accordance with FRA requirements at 49 *CFR* Part 219, NJT administered toxicological tests to nine employees on February 9, 1996, within 7 hours of the accident. Six employees, including three surviving crewmembers of trains 1254 and 1107 and the director, assistant director, and a

leverman at the Hoboken terminal tower, submitted blood and urine samples at St. Mary’s Hospital in Hoboken. Medical personnel obtained samples from the injured conductor of train 1254, who had been transported for treatment to the Meadowlands Medical Center in Secaucus. Urine specimens from these employees were sent to Northwest Toxicology, Inc., Salt Lake City, Utah, for examination. All tests were negative for drugs, including alcohol.

The New Jersey State Medical Examiner collected blood and tissue specimens from both fatally injured engineers for toxicological tests. He reported that no drugs, alcohol, or other compounds were detected in the blood of either engineer. The engineer of train 1107 tested positive for Salicylate (Aspirin) screen.

The Safety Board obtained toxicological specimens from both engineers, which it forwarded for examination to the Center For Human Toxicology in Salt Lake City, Utah. The laboratory reported that caffeine was detected in the blood specimens of both engineers. No other drugs, including alcohol, were detected.

## **Survival Factors**

This section is divided into four main sections: the NJT safety awareness program, post-collision actions by NJT crews, postcollision actions by emergency responders, and the crash-worthiness of the trains.

### ***NJT Safety Awareness Program***

***Employee training***—The NJT employee training program has two types of courses: job-specific, such as the “Assistant Conductor” program, and skills enhancement, such as the “Tunnel Evacuation” course and the “Passenger Assistance/Sensitivity” course. All new operating employees, including engineers, conductors, assistant conductors, and dispatchers, are required to take the program of classes specific to their position before beginning work in that type of job. Certain skills enhancement courses are also required for employees in particular jobs. All employees may request to take any of

the skills enhancement courses, but those whose positions require the training have priority.

All of the job-specific courses include instruction on emergency procedures, including types of emergencies, types of evacuations, responsibilities of crewmembers, crowd control techniques, and proper communications. Many of the skills enhancement courses contain applicable emergency procedures. Most of the instruction is classroom lecture. Further, most of the courses use written tests to evaluate what an employee has learned. Courses such as the passenger assistance class and the customer sensitivity class do not administer written tests. Students are required to use the techniques taught in role-playing scenarios, which the instructor then critiques. None of the regular courses includes site simulations, or drills, in emergency procedures. Employees receive hands-on training simulating an actual emergency on a train only if they participate in joint disaster drills with emergency response personnel.

The NJT training program requires all operating employees, including engineers, conductors, assistant conductors, and train dispatchers, to attend an annual operating rules instruction class and successfully pass a written test on the subject matter presented. The railroad has no time requirement for employees to attend periodic refresher courses on emergency evacuation procedures. Personnel records indicate that the last time the conductors and assistant conductors on trains 1107 and 1254 had received any emergency training ranged from 1 to 9 years before the accident. When interviewed after the accident, the assistant conductor of train 1254 recalled that he once had attended a training session on evacuating from a tunnel. The train 1107 conductor recalled having had emergency evacuation training. The assistant conductor of train 1107 did not recall having received emergency evacuation training.

*Operating manuals*—Each employee receives a copy of NJT's *Timetable No. 9* that contains emergency evacuation procedures. Further, the rail operations center in Hoboken maintains for employee reference the NJT's

*Standard Operating Procedures Manual* that contains procedures for handling rail emergency evacuations, smoke and fire in tunnels, and bomb threats.

*Public safety awareness*—The NJT provides a brochure, *Emergency Response Guidelines*, to police, fire, and EMS personnel when they attend the New Jersey Rail Operations Emergency Responder Training Program. The transit company also posts safety awareness posters and places general and seasonal customer safety bulletins in the trains and stations. One customer brochure includes procedures that passengers should follow in the event of an emergency on a New Jersey Transit train or bus.

*Actions by NJT Crews*—In addition to interviewing the crews, the Safety Board sent questionnaires to a sampling of the 400 passengers who had been on board the accident trains to obtain their recollections of the events following the collision. Of the 253 people surveyed, 71 responded to the questionnaire.

*Crew recollections*—The assistant conductor of train 1107 said that he and the conductor were collecting tickets and talking to passengers when he felt a jolt and the train came to a stop. "I ran out, saw the cab car (of train 1254), and went blank. I said to one of the deadheading employees, 'What do I say?' He said (to call) emergency." The train 1107 assistant conductor said that he started to make the call when he heard someone else on the radio reporting the emergency. He added, "The only thing I was concerned about was the engineer (of 1254)." He said that he screamed to another employee that they had to help the engineer. He said that as he ran into the train 1254 cab car, passengers were scrambling out. He said when he saw the bleeding conductor of train 1254, "I asked him about the engineer and he asked me to help him get the passengers out...."

The conductor of train 1107 testified that she heard a bang, and the train started to lean to the right. She said:

...my biggest fear was (if) everybody stood up...that would tip us over the rest of the way...I yelled for everybody to stay calm....When I looked out, I saw the cab car (of train 1254)...I ran back to the radio (in the hind car), but there was a lot of activity on the radio already....By then passengers were everywhere. They were on the tracks....I don't know what happened to my rear brakeman (the assistant conductor)...he wasn't on the train. As I was walking forward I was thinking that my engineer should be back here now, and then I started to run. I started asking the passengers, did anybody see the engineer running back this way. And no one said anything. Everybody was like stunned or something.

The engineer who stopped his commuter train to render assistance said that after radioing Hoboken, he pulled his train to within one car length of the accident trains and got out to check on the engineer in 1107. When he saw the fuel tank was leaking, he climbed aboard and "hit the emergency fuel shutdowns." When he got down off the locomotive, he encountered the train 1107 conductor whom he described as "hysterical." He said that he told her to get herself together...(and) to "get those people back on the train. We have fuel leaking. Don't let them light any cigarettes."

One of the deadheading employees stated that his first thought was that the accident trains were blocking just enough track to cause "another sideswipe" by a train traveling on the adjacent track and that someone needed to flag down any on-coming trains. He said that the train 1107 conductor "...just wasn't in the frame of mind to think about that....We tried to calm her down. She was screaming somebody was dead up front." He said that after checking out the engineer in train 1254, he went around the back end of 1107 where "...passengers were milling all about."

During postaccident interviews, the conductor of train 1254 stated that he did not know

whether the public address system had been functional because he had not tried to use it. The conductor of 1107 did not recall if the public address system on her train was working. Examination of the equipment after the accident showed that the public address systems on both trains were operating as designed.

**Passenger observations**—Several surveys stated that the crews did not provide any instructions about exiting the train after the collision. One passenger recalled that the crew was "basically calm, instructing passengers on where to go and how to proceed." Another passenger said that the conductor of train 1107 was crying when she told riders that a collision had occurred and two people aboard the east-bound train had been killed. Several passengers stated that they felt the crew was helpful in instructing them to remain on board the train; others said they felt uncomfortable remaining onboard in case of a fire or being hit by an oncoming train, so they decided to detrain. Other surveys variously described the crew as "crying and upset after the accident," "fairly upset and seemed rather nonfunctional due to their emotional state," or "dazed and stunned like everyone else." One responder stated that the crews "...definitely did not take charge."

**Emergency Response**—The accident occurred in a remote area between Secaucus and Jersey City, New Jersey, accessible only by a single narrow, muddy dirt road. Upon being notified of the accident at 8:40 a.m., Hoboken dispatch center personnel first notified the NJT central communication center, which in turn dispatched three NJT police units to the scene and notified emergency medical services (EMS) personnel, police, and area fire departments.

According to incident command reports, 24 agencies responded to the accident. The Jersey City Fire Department dispatched eight engine companies, three truck companies, a special squad, a rescue unit, and a hazardous materials unit, totaling about 75 personnel. The Jersey City EMS dispatched more than 90 units, including 70 basic life support units, 8 advanced life support units, 2 mass casualty response units, 1 EMS rescue unit, 2 medical evacuation

helicopters, 8 supervisor units, 2 basic life support non-transport units, and 1 field communications unit. Police reports indicate that 40 officers assisted with traffic and crowd control, searched the trains, provided first aid, and helped evacuate passengers.

The first NJT police officer arrived at the scene at 8:53 a.m. Buses were sent to the scene to transport passengers. Emergency personnel said that the number and size of vehicles responding to the scene caused congestion and made it difficult for them to maneuver emergency vehicles close to the collision site. The incident commander subsequently established a staging area for vehicles about 1/2 mile away from the site to facilitate the movement of ambulances. The NJT's mobile command center arrived at the scene about 10:30 a.m. to coordinate the activities of responding agencies.

The fire chief stated that he had a problem communicating with the different agencies at the accident scene because various departments were using radios tuned to different frequencies. The fire chief said that because of the lack of a common frequency, he continually had to move from train car to train car and from train to train to verbally coordinate activities with response agency personnel.

According to the Hudson County deputy emergency management coordinator, the county had purchased a radio network system, which is located at the Hudson County Police Department, about 15 years before this accident. The system has one base station for each of the twelve municipalities and one mobile unit for each of three county areas, thereby affording all response agencies the capability to communicate on a common frequency. However, at the time of this accident, only the Jersey City Fire Department had purchased radios that were compatible with the network system, therefore it could not be used.

Following this accident, officials of the responding agencies convened to critique the emergency effort. As a result of the meeting, all emergency response agencies agreed to pur-

chase radios having the capability to carry the county radio network frequency.

**Wreckage**—The lead truck of train 1254's cab car, unit 5146, had derailed about 4 to 5 feet off of the rail. The roof of the car was sheared off on the right side near the front end. Train 1107's locomotive unit, NJT 4148, sustained major intrusion and crush damage to the engineer's side of the locomotive.

**Train 1254**—All five cars sustained damages; the locomotive unit had no reported damages. The lead unit, cab car 5146, which was a Comet II type car (figure 7) with a body constructed primarily of aluminum extrusions and aluminum sheet metal, suffered major damage. The right<sup>11</sup> buffer wing, which is attached to the corner post stub, had separated from the car. The end sheet had separated from the car. The floor in the engineer's compartment had been sheared off. The trap door and stairwell were missing. The right side of the compartment roof, outboard of the collision post, had been sheared off. A 10-foot section of roof rail had broken off and lodged in the locomotive cab of train 1107. The interior bulkhead directly behind the engineer had been pushed rearward at the bottom and pulled down at the top. The engineer's seat had folded back into the bulkhead. The first two seats aft of the bulkhead, where the deceased passenger had been sitting, had been pushed rearward into the seats behind them. The space normally occupied by these seats was filled with debris.

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<sup>11</sup> Right refers to the engineer's side.

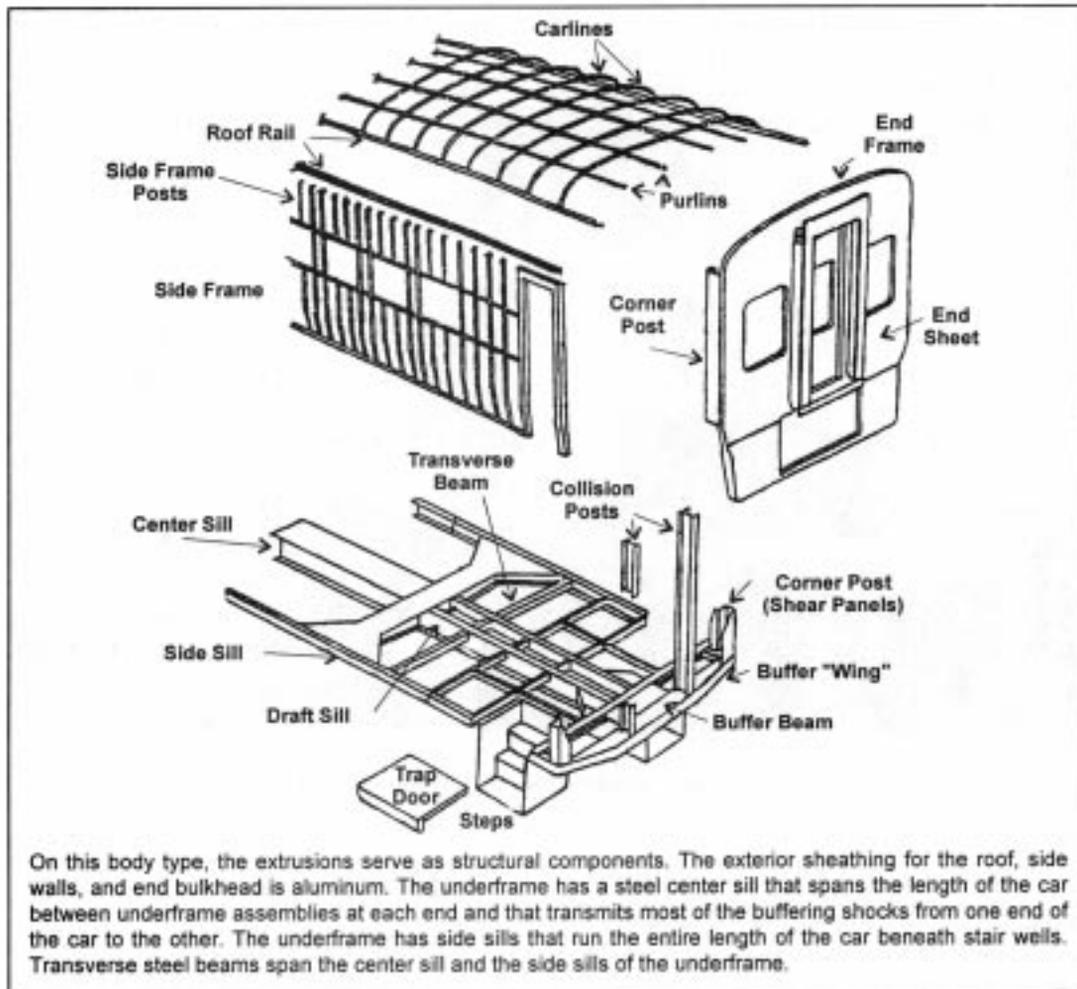


Figure 7—Comet II type car



Figure 8—Photograph of unit 5146, the cab car of train 1254



Figure 9—Photograph of unit 4148, the locomotive of train 1107

*Train 1107*—Five of the six cars suffered some degree of damage; the locomotive (figure 9) sustained damage to the end plate, plow, and short hood on the engineer's side. Several feet of the cat walk on that side of the locomotive received impact damage, and collision debris was piled along the walkway. The right front collision post within the short hood compartment was still intact. However, the right corner of the short hood compartment enclosure was pressed into the nose compartment about 12 inches. The windshield corner post on the right side was pushed inward and the side of the cab roof was pulled down. The maximum roof deflection was 26 inches. A 10-foot section of the roof rail from the cab car of train 1254 was found lodged diagonally across the cab of the locomotive unit. One end of the roof rail was lodged against the bottom inboard side of the windshield corner post. The other end was imbedded into the electrical control panel directly above the fold down seat. This section of roof rail had struck the engineer's control stand, rotating it about 40 degrees aft.

## Tests and Research

Safety Board investigators conducted visibility, sight-distance, speed, and stopping tests on February 11 and 13, 1996, using the same equipment that was on train 1254, except for the cab car 5146, which was destroyed in the collision. A cab car of the same type was used in the tests. The weather conditions were comparable to those on February 9, 1996. Measurements showed that train 1254 was 165 feet past signal 28E-1 when it struck train 1107 and that it stopped 236 feet past the signal after striking the train.

**Visibility Tests**—Safety Board investigators conducted visibility tests beginning about 8:20 a.m. and observed the signals through 8:40 a.m. No shadows, reflections, or glare from the sun limited the visibility of the signals.

**Sight Distance Tests**—Safety Board investigators conducted sight-distance tests from the engineer's seat in the cab car. Investigators

readily could see the approach signal (R6) from the signal that preceded it (signal 422), a distance of 5,000 feet. Investigators readily could see signal 28-E1 from the approach signal (R6), a distance of 1,230 feet. Neither weather nor site conditions resulted in sight restrictions from signal to signal.

**Speed and Stopping Tests**—The Safety Board performed six tests, four of which were at 20 mph, the speed at which train 1254 was traveling shortly after it passed signal R6. In two 20-mph-tests in which a full service brake was applied, the respective stopping distances were 165 feet 10 inches and 166 feet. In the two 20-mph-tests in which emergency braking was applied, the respective stopping distances were 210 feet 1 inch and 246 feet 8 inches.

**Event Recorders**—The locomotive unit and the cab car of both trains were equipped with event recording machines. Safety Board investigators removed the recorders shortly after arriving on scene, and together with FRA, and NJT investigators, downloaded the data from each machine for tests and simulations. The recorders were then delivered to the Safety Board's laboratory in Washington, D.C. for further analysis. The event recorder on the train 1254 locomotive taped data related to the train's movement, such as time, speed, throttle, and reverser position. The Safety Board found that the tape for the cab car recorder, which registers brake applications, had not been fully inserted; therefore, analysts could not verify when the engineer had applied the brakes.<sup>12</sup> The laboratory report on the tape readout indicates that after train 1254 departed Harmon Cove station east-bound on the Bergen County line, its speed increased to 53 mph, then gradually reduced to 34 mph at the R6 signal, and then to 23 mph when it was 71 feet from the stop signal at 28E-1. At this point, the throttle was applied and the train accelerated. Train 1254 continued past the

stop signal and was traveling about 18 mph when it struck train 1107.

## Other Information

**NJT Postaccident Actions**—In addition to having its staff conduct an investigation of the Secaucus accident, the NJT convened a committee to assess potential risk factors to safety within its operations. In a letter to the Safety Board, the executive director of the NJT listed the staff recommendations endorsed by the NJT Board of Directors, including the elimination of the transit company's two overnight split shift assignments by September 1996 and installation of signal system enhancements by 2001. The NJT official stated that the industry's decreasing use of such overnight split shifts and recent studies had prompted the company's decision to eliminate overnight split shift assignments. The official indicated that the NJT had a capital improvement program that originally had called for cab signals and positive train separation (PTS) systems to be installed in all trains by 2006. The letter states, "By December 31, 1997, all NJ Transit rail lines will be equipped for either cab signals or positive train stop, and by December 31, 2001, all NJT lines will be equipped with both technologies."

Further, NJT officials advised the Safety Board that they have enacted more stringent disciplinary measures for locomotive engineers. Before this accident, the NJT had suspended engineers who passed stop signals for a minimum of 30 days in accordance with FRA regulations. The NJT now requires the engineer to attend a special recertification training class before returning to work. Additionally, rather than impose a suspension of at least 1 year as required by FRA regulations, the company policy now requires that an engineer be dismissed for a second stop signal violation.

**FRA Emergency Order**—As a result of this accident and a February 16, 1996, near-head-on collision between a commuter train and a National Railroad Passenger Corporation (Amtrak) train near Silver Spring, Maryland, in

<sup>12</sup> The FRA granted the NJT a temporary waiver of compliance from certain provisions of Title 49 CFR Part 229.135 requiring that all trains operating over 30 mph be equipped with event recorders by May 1995. The NJT has an extension until May 1997.

which 11 people died, the FRA issued Emergency Order No. 20 (the Order) on February 21, 1996, which contains immediate and proposed rules changes for commuter and intercity passenger railroads. The Order requires such railroads to prepare and file with the FRA an interim safety plan that addresses, among other issues, management of operating crews. The Order notes the NJT's decision to eliminate night split shifts following the Secaucus accident and requires that passenger railroads to review their operations "to determine if opportunities exist for risk reduction similar to the action taken by New Jersey Transit."

### **Medical Standards**

**Federal standards**—The fitness requirement for certification of locomotive engineers contained in *CFR* Part 240.121 (c ) states, "Except as provided in paragraph [240.121] (e)," a person must meet or exceed the following visual acuity thresholds:

- (1) For distant viewing either
  - (i) Distant visual acuity of at least 20/40 (Snellen) in each eye without corrective lenses or
  - (ii) Distant visual acuity separately corrected to at least 20/40 (Snellen) with corrective lenses and distant binocular acuity of at least 20/40 (Snellen) in both eyes with or without corrective lenses;
- (2) A field of vision of at least 70 degrees in the horizontal meridian of each eye; and
- (3) The ability to recognize between the colors of signals.

Paragraph (e) states:

A person not meeting the thresholds...of this section may be subject to further medical evaluation by a railroad's medical examiner to determine that person's ability to safely operate a

locomotive. If the medical examiner concludes that, despite not meeting the threshold(s), the person has the ability to safely operate a locomotive, the person may be certified as a locomotive engineer and such certification conditioned on any special restrictions the medical examiner determines in writing to be necessary.

**NJT protocol**—According to company officials, NJT has had a standard practice addressing physical requirements for personnel before it took over the commuter rail system from Conrail in 1983. The NJT contracts with area practitioners to perform employee physicals. In 1990, the company appointed a full-time medical services chief who established a protocol of visiting the fee-for-service physicians to determine if their offices complied with NJT's basic standards. Before this accident, the NJT medical services staff last had made an oversight visit to the company's contract physicians in 1993, at which time several offices were dropped from contract for failing to maintain NJT's basic medical standards.

After this accident, the NJT Medical Office established specific fitness for duty standards, including vision testing requirements, for rail operations employees. The NJT has given each of its contract doctors a handout listing the tests to be conducted for each class of employee and what measures to take if any abnormalities are detected. The testing protocol states, "Employees are not to be returned to work unless the medical issues are resolved in full."

The NJT vision screening now requires the physician to conduct ten tests, including the Dvorine PIP test or a comparable color-screening examination, the Ishihara PIP test. Further, the NJT testing protocol now requires a physician to refer an employee for additional testing if the employee cannot identify any one of the 15 Dvorine plates.

The medical services director also conducted a program of review related to employee physicals to ensure the compliance of its fee-for-

service practitioners with Federal Regulations and NJT Corporate procedures. Medical services staff visited each of the contract physicians to review their operations and to determine if they had any questions about or problems with NJT protocol. The medical services director stated in a February 1997 letter to senior company officials that as a result of the 1996 oversight visits by medical staff, she had dismissed some of the NJT contract physicians and hired others who have facilities that will enable them to “consistently comply with our standards.”

### ***Railroad Safety Advisory Committee***

**Background**—The Railroad Safety Advisory Committee (RSAC), a group of carrier, union, and government representatives, was established to provide advice and recommendations to the FRA regarding the development of the railroad safety regulatory program, including the review and revision of existing regulations. The RSAC structure has three levels: (1) the RSAC committee itself; (2) working groups responsible for developing recommendations on one or more tasks assigned to the RSAC by the FRA; and (3) task forces that accumulate data and recommend actions for the working groups.

**Pending issues**—On October 12, 1995, the FRA presented an issues paper to RSAC asking the committee to determine by July 1997 the adequacy of the current engineer qualifications standards. The FRA asks RSAC to review, among other safety considerations, the hearing and vision acuity standards in 49 *CFR* 240. The issues paper states:

FRA believes that the current hearing and vision acuity standards comply with the Americans With Disabilities Act and that they adequately assure that locomotive engineers possess the requisite physical abilities to do their jobs. Meanwhile, FRA is aware of at least two or three persons who were dissatisfied with the way in which the rule was enforced to their detriment. In addition, FRA is aware of at least one instance in which an engineer was denied certification by one railroad due to the inability to recognize and distinguish between the colors of signals and yet was certified by another railroad....FRA recommends that RSAC refer this issue for review by a working group if RSAC can develop any reason(s) why the current rule may need amending.

# ANALYSIS

## General

This analysis is divided into three main sections. In the first part, the Safety Board identifies factors that can be readily eliminated as causal or contributory to the accident as a result of its investigation. The second section focuses on the accident sequence, discussing actions and events resulting in problem conditions. In the final section, the Board discusses the findings that support each safety issue identified in this investigation.

## Exclusions

The weather and visibility were not factors in this collision. Witnesses stated that it was clear and sunny. During visibility tests conducted at the same time of day and in similar weather conditions, Safety Board investigators determined that no shadows, reflections, or glare from the sun would have limited the visibility of the signals. Nothing in the predeparture tests, the postaccident equipment inspection, or the event recorder data indicated any equipment failure. Also, the train crew reported no mechanical problems while the train was enroute. Pre-and postaccident track and switch inspections showed no anomalies. Pre- and postaccident inspection of the signal system indicated that the signal system functioned as designed, in accordance with FRA requirements. Signal inspection reports and block operators' statements indicated no deficiencies that would prevent proper operation of the signal system. Therefore, the Safety Board concludes that the weather, the train equipment, the track, and the signal system did not cause or contribute to the collision.

All crewmembers had the necessary initial training to competently perform their operational duties. The toxicological tests for alcohol and

drugs were negative for all those tested. No evidence indicated that fatigue may have affected the crewmembers' performance. The Safety Board particularly scrutinized the work habits and rest cycle of the engineer of train 1254. Although a complete account of his daytime activities could not be reconstructed, observations by his co-workers and his spouse indicate that he did not vary from his regular routine and that he probably received his usual rest. He may or may not have worked at his part-time business after getting off work Thursday morning; he slept Thursday afternoon before reporting for work; and he slept about 4.5 hours during his split shift break. At the time of the accident, the 1 hour and 12 minutes that he had been in an overtime status for the railroad probably coincided with the time that he usually was preparing to begin work at his business. The Safety Board therefore concludes that fatigue, operational training, and alcohol or drug use were not factors in the collision.

## Analysis of the Accident

Eastbound train 1254 departed Harmon Cove station en route to Hoboken about 8:33 a.m. Event recorder data show that the engineer was actively controlling his train from the time he left the station until the collision. According to block operators controlling the signals, as train 1254 neared the West End interlocking, the approach signal was displaying a red/yellow/red aspect, indicating proceed prepared to stop at next signal (in this case signal 28E-1). Event recorder data show that when train 1254 passed the approach signal, it was coasting, which would be a common maneuver by an experienced operator who was allowing rolling resistance to slow the train in preparation to respond to the next signal. However, when train

1254 was less than 100 feet from signal 28E-1, which was displaying a red/red/red, or *Stop*, indication, the engineer applied the throttle, accelerating the train past signal 28E-1 at 20 mph. Sand on the tracks indicates that the train went into emergency braking shortly thereafter, probably the result of the engineer applying the brakes when he saw that the interlocking track was not lined for him or that train 1107 was in his path. Despite the emergency brake application, train 1254 was traveling 18 mph when it struck westbound train 1107, which was traveling 53 mph on a clear signal on main line track No. 1. The right front corner of train 1254's cab car struck the right front corner of train 1107's locomotive, instantly killing the engineer of train 1107. The engineer and a passenger in the cab car of train 1254 also died as a result of injuries sustained in the collision.

The Safety Board identified three primary safety issues in this accident: the medical condition of the train 1254 engineer, the adequacy of medical standards for locomotive engineers, and the adequacy of the train crews' response to the accident. The Safety Board also examined crashworthiness of the trains and the response effort by emergency personnel.

## **Medical Condition of the Train 1254 Engineer**

The Safety Board attempted to determine why the train 1254 engineer, a highly experienced railroad employee with 40 years overall railroad service and 34 years service as a locomotive engineer, proceeded past the stop indication at signal 28E-1. His operating errors since 1989 had been minor infractions, typically resulting in verbal warnings. He had been recertified less than 2 years before the accident. Postaccident tests determined that all signals in the vicinity of the interlocking were functioning properly.

In his approach to signal 28E-1, the engineer did not merely fail to stop; he actually accelerated as if he had received a more favorable signal indication. Signal 28E-1 is a pole-

mounted, long-range color-light-type device with three heads in a vertical array. During post-accident sight distance tests, when Safety Board investigators were measuring the sight distance to the approach signal (R-6), they readily could see the colors of the illuminated lenses on two heads of signal 28E-1. Had signal 28E-1 not been partially obscured by brush next to a curve in the track, testers would have been able to state that the sight distance to signal 28E-1 was more than a mile. The investigation disclosed that the medical condition of the engineer, specifically his diabetic retinopathy and resulting color vision deficiency, probably affected the manner in which he operated his train on the day of the accident.

During its review of NJT medical records, the Safety Board noted that the train 1254 engineer had been medically disqualified from duty in 1987 when a urine sample taken during his company physical showed the presence of sugar. The medical files of his personal physician revealed that at the time of the accident, the engineer had been a non-insulin-dependent (type II) diabetic for 19 years. As part of its physical examination protocol, the NJT requires its employees to report certain medical conditions, including diabetes, and the use of all prescription medications on a medical history form. However, when the engineer was disqualified from duty, he sought treatment from his personal physician to obtain medicine to control his diabetic condition. After taking the medicine for 2 weeks, the engineer provided the NJT physician with a urine sample that did not show the presence of sugar, whereupon he was reinstated. He did not report his diabetes or the medication he was taking to the NJT at that time or on the history forms for any subsequent NJT physicals. Thus, by not reporting his diabetic condition and his medication, he was able to avoid any adverse effect it might have on his assignment and employment. The Safety Board concludes that the engineer of train 1254 consistently failed to report his medical condition to NJT contrary to the railroad company's medical testing requirements.

The engineer's personal medical records indicate that his vision deteriorated dramatically during the year before the accident. He underwent several laser surgeries in both eyes to correct for the effects of diabetic retinopathy; however, the disease continued to develop. Records of his last eye tests indicate that he had little vision in his left eye (20/400 acuity with correction), and the vision in his right eye varied from 20/30 to 20/70 (with correction). Significant complications occurred in the engineer's "good" right eye, resulting in proliferative retinopathy. Panretinal photocoagulation surgery was performed to treat proliferative retinopathy in the engineer's right eye as late as January 1996, 2 weeks before the accident.

Research has shown that in addition to a loss of visual acuity, many patients with severe retinopathy fail color discrimination tests. As part of his company physical, the engineer had been given the Dvorine PIP test, a reliable measure of color discrimination, annually since 1985. Between 1985 and 1993, he missed none of the Dvorine plates. In 1994, he missed 2 of 15 plates. During his February 1995 test, he missed 6 of the 15 plates and was classified as having a moderate color vision handicap. The sudden decrease in color discrimination ability in the 1995 examination was accompanied by a small decrease in visual acuity in his left eye. These vision changes suggest that the engineer's advanced diabetic retinopathy resulted in a deterioration of visual acuity and an acquired color vision deficiency.

Signal 28E-1 at the interlocking is a color-coded signal that contains three aspects in a vertical array, with a light always illuminated in each aspect. The color of each aspect and the order of colors from top to bottom determine the signal indication. The signal has no non-color cue that provides comparable information at all viewing distances and in all conditions. The colors red and yellow are used in three combinations. The top aspect always displays a red light, and the middle and bottom aspects can display either a red or yellow light. The signal indications (from top aspect to bottom aspect) are *Stop* (red, red, red); *Restricting* (red, red,

yellow), meaning proceed at restricted speed until the entire train has passed a more favorable signal; and *Medium Approach* (red, yellow, red), meaning proceed prepared to stop at the next signal.

Individuals with color vision deficiency are known to identify colors in some situations by their relative brightness rather than their hue. If an individual with color vision deficiency cannot discern the actual colors of red or yellow signal lights that are adjacent to each other, he probably would identify the brighter light as yellow and the dimmer light as red, regardless of which is actually yellow or red. In the case of the train 1254 engineer, he had been recertified for duty, albeit erroneously, when he was able to name the respective colors on the Dvorine nomenclature test, probably by virtue of their relative brightness rather than their hue.

Given his color vision deficiency, the engineer could have erred when interpreting the illuminated lenses at signal 28E-1. He might have perceived that either the middle or bottom aspect was brighter than the top aspect. Believing the brighter aspect to be yellow, he might have interpreted the signal to be a *Medium Approach* or *Restricting* indication rather than a red *Stop* indication. His train handling supports this finding. At the approach signal, he correctly slowed his train as an engineer typically would do when encountering a *Medium Approach* indication. He continued to slow as he neared signal 28E-1, which can clearly be seen by a person with normal vision from at least 1,230 feet.<sup>13</sup> However, about 71 feet before signal 28E-1, which was displaying three red aspects, he began to accelerate. The Safety Board concludes that the engineer's acquired color vision deficiency caused him to interpret the color-coded *Stop* indication at signal 28E-1 to be either a *Restricting* indication or a *Medium Approach* indication, either of which would have allowed him to proceed past the signal.

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<sup>13</sup> Based on postaccident sight distance tests conducted by the Safety Board.

## Adequacy of Medical Standards for Locomotive Engineers

During his 1995 NJT physical conducted by a fee-for-service practitioner, the engineer who caused the accident had not been able to identify numbers on several color-coded plates of the Dvorine PIP examination, which vision specialists recognize as being a reliable test for identifying color vision deficiencies. The physician then administered the Dvorine nomenclature test, which is used to determine if a patient knows the correct names of colors. After the engineer correctly named the colors on the color wheel, the physician certified him for duty. The nomenclature test instructions specifically state that the test is not to be used to determine an individual's color discrimination ability. The doctor later stated that he believed that the nomenclature test was a supplemental examination to the PIP test. The Safety Board concludes that the fee-for-service physician's failure to comply with the Dvorine nomenclature testing protocol resulted in the erroneous certification of the train 1254 engineer for duty.

Despite the doctor's error, the argument can be made that the testing and certification of this engineer was in compliance with Federal certification standards, which only require that an individual have "The ability to recognize and distinguish between the colors of signals." Further, the *CFR* allows a medical examiner to certify an engineer with restrictions if the doctor concludes that despite the individual not meeting the color vision threshold(s), he or she has the ability to safely operate a locomotive.

The Safety Board believes that the color vision requirement for railroad engineers is extremely important because color is the primary information cue in safety-critical visual signals. Moreover, the colors used in signal aspects are very likely to be confused by individuals with color vision deficiency. Current Federal regulations do not specify how to test for the ability to discriminate colors, rather, they permit a railroad to select the test or method it will use to determine if its engineers comply

with the regulation. As a result, tests may differ from railroad to railroad, or even from one medical examination to another. While railroad physicians may be aware of the color vision requirement for locomotive engineers, they may not recognize which color vision test is a valid measurement tool.

Many available tests are undesirable; other tests can be inconclusive by themselves. The Secaucus accident and other cases demonstrate that perhaps an alternative evaluation method, such as a color vision test that accurately simulates color-coded railroad signals, should be developed as an additional screening for railroad employees in safety-sensitive positions. Such a test would have the advantage of having high validity to applicants being tested, to those administering the tests, and to judges who may decide arbitration.

In an issues paper presented to RSAC regarding engineer certification standards, the FRA has stated that it believes that the current hearing and vision acuity standards comply with the Americans With Disabilities Act and that they adequately ensure that locomotive engineers possess the requisite physical abilities to do their jobs. However, the FRA recognizes that the testing and the interpretation of test findings is not uniform and therefore has asked the RSAC to address the issue. The FRA cites as an example a case in which an engineer who upon failing a vision examination given by one railroad physician applied to work at another railroad whose physician certified him. The Safety Board concludes that Federal standards lack testing criteria to ensure that vision tests will be administered uniformly or effectively. The Safety Board believes that the current standards should be revised to specify the tests, testing procedures, and scoring criteria that railroad physicians should use in administering color vision tests.

This accident highlights another problem that a physician has in determining the fitness for duty of railroad engineers. In this case, the

engineer of train 1254 did not advise the fee-for-service doctor about his diabetes, his vision problems, or his prescription medications. Because the engineer died, the Safety Board cannot determine whether he failed to recognize or refused to admit to the potential risk in which he was placing himself and his passengers when he operated a train. The reasons for people not admitting to medical problems are as diverse as the individuals themselves. The Federal Aviation Administration (FAA), recognizing this, has enacted the following standard as a requirement for the medical certification of pilots:

No person may act as pilot in command ... while he has a known medical deficiency, or increase of a known medical deficiency, that would make him unable to meet the requirements of his current medical certificate.<sup>14</sup>

The Safety Board believes that for the safety of the traveling public, it is just as necessary to compel railroad employees in safety sensitive positions, especially engineers, to disclose any change in their physical status that might affect how they perform their job. As an interim measure, industry associations, such as the American Public Transit Association, the Association of American Railroads, the Brotherhood of Locomotive Engineers, and the United Transportation Union, can also assist in improving railroad safety by providing their members with information about this accident, specifically explaining acquired vision deficiency and emphasizing the importance of ensuring the color vision requirement. Further, associations should stress that railroad employees in safety-sensitive positions, especially engineers, report their use of medications or any changes in their medical condition to their employer.

After this accident, the NJT medical services office initiated a number of measures to ensure compliance with Federal regulations and NJT procedures. The NJT changed its color vision testing protocol to require that a physician refer an employee for additional testing if

the employee cannot identify any one of the 15 Dvorine plates. Further, medical services office staff visited each of the carrier's medical practitioners to review their operations. The Safety Board finds that the NJT medical review is an effective risk management measure that NJT should formalize as part of its on-going management oversight program. The Safety Board does believe that as an additional measure, the NJT should inform its employees, especially those in safety-critical positions, of the facts and circumstances of this accident stressing that they must accurately report their use of medications or any changes in their medical condition.

## Adequacy of the Train Crews' Response

**Postaccident Actions**—Although the conductor on train 1254 was injured during the impact, he was able to evacuate passengers before he was transported to the hospital. The assistant conductor on train 1254 asked passengers if they needed assistance and used his cellular phone to call NJT officials for help. The conductor on train 1107 was visibly upset and crying, which caused concern among the passengers. However, when NJT employees who were deadheading on the train realized that the train 1107 conductor was in no condition to assess the situation and to make necessary decisions, they took control of the situation. To prevent another accident, they prepared to flag down an oncoming train; they tended to and helped evacuate the passengers. When the emergency responders arrived on scene, passengers were safely moved to another NJT train, triaged, and transported to local hospitals. The Safety Board concludes that the evacuation of passengers from the accident site was not hampered even though the actions of some train crewmembers were less than adequate.

The scenario after the Secaucus accident is typical of the conditions and problems following a major train collision, which require the skills of trained personnel who can maintain

<sup>14</sup> 14 CFR 61.53

their composure, make decisions, and control and inform passengers to prevent further injuries and panic. Because injuries were involved, this accident met NJT's criteria for a "Critical Emergency," which require that the conductor and other train employees manage the emergency to make sure that trains are stopped and appropriate instructions are given to passengers to avoid panic. The assistant conductor on train 1107 said that he went "blank" after the collision and had to ask a deadheading employee what he should say on the radio. He said that upon seeing the damage to the train 1254 cab he ran out of the door screaming for the engineer. The uncertainty of the situation also caused the train 1107 conductor to panic. She said that she instructed the passengers in two cars to remain seated; however, her demeanor and lack of direction compromised her effectiveness.

According to passengers, the crewmembers on trains 1254 and 1107 provided few instructions. Only one survey respondent stated that he heard an announcement over the public address system, but he did not know if it had been a crewmember or an emergency responder who made the announcement. Other passengers said that they heard no announcements. Although the train crews said that they went from car to car instructing passengers to remain seated, passengers said that they were not told about the severity of the situation and were concerned about a possible fire or being struck by an oncoming train. They therefore left the train and wandered around the tracks waiting for guidance, potentially posing a greater hazard because of the leaking fuel from train 1107.

No crewmember used the public address system to communicate with passengers. By using the public address system, all passengers would have received the same message in less time than it would have taken the NJT employees to walk from car to car. The assistant conductor on train 1254 stated that he did not know if the public address system worked because he did not try to use it. The conductor on train 1107 stated that she did not recall if the public address system worked. Postaccident tests revealed that the public address systems on

both trains were operable after the collision. Information about the possibility of a fire or a collision with an oncoming train could have been provided to passengers over the public address system to address their concerns and prevent them from leaving the train. The Safety Board concludes that the lack of public announcements addressing the passengers' concerns caused them to act independently, evacuate the train, and wander along the tracks, thus potentially contributing to the dangerous conditions at the collision site.

**Employee Training**—The NJT provides its train crews with emergency procedures training; however, it does not have a refresher training program that establishes a time frame within which employees must attend a refresher course in emergency response actions. The last emergency training that the surviving crewmembers on the accident trains had taken ranged from 1 year to 9 years before the accident.

The assistant conductor on train 1107 stated that he did not recall receiving emergency evacuation training. Records show that it had been 9 years since he had attended a transportation training program and 4 years since he had received customer sensitivity training that focused on emergency evacuation procedures. Perhaps he could not recall receiving the evacuation training because of the 4-year time span since his last course. It is reasonable to believe that if he could not recall attending the course, he probably could not recall the subjects covered. Such a time gap between training does not provide the necessary frequency to reinforce special skills. By periodically attending a refresher course, employees can become more effective in managing an emergency situation.

Drills are not included in NJT's training program even though most classes provide some instruction about emergency procedures. Employees participate in drills only if they are selected to participate in training for emergency responders. The Safety Board believes that drills should be incorporated into the training program

to help employees learn to properly assess an emergency situation, to manage passengers, effective panic control techniques, and effective communication skills. Passengers depend on train employees for leadership and guidance in an emergency. NJT employees should be prepared and confident that they can provide appropriate emergency services should the need arise.

The Safety Board concludes that the performance of train crewmembers during emergencies could be improved if the NJT included drills and refresher training in its training program. The Safety Board believes that the New Jersey Transit should conduct drills as part of its training program and develop a refresher training program so that all employees with responsibilities during emergencies receive periodic refresher training to reinforce their skills.

## Survival Factors

**Crashworthiness**—The train 1107 locomotive and the train 1254 cab car collided at an oblique angle, approximately engineer's side collision post to engineer's side corner post. In the initial moments of the collision, the cab car's right side buffer wing was torn from the draft sill outer webbing, significantly reducing the car's ability to resist intrusion into the engineer's compartment in the cab car. As the collision progressed, the right front of the locomotive passed through the engineer's compartment. Except for the anti-telescoping plate and components below the underframe, all other structural and non-structural components of the compartment were torn loose, forced aft, or pushed into the car interior. As the locomotive moved forward during the collision, a section of the cab car's roof rail passed over the short hood of the locomotive and entered the cab, striking the train 1107 engineer in the head and neck area and fatally injuring him.

The fatally injured passenger in the cab car of 1254 was exposed to severe forces, demonstrated by the fact that he was thrown across the car with enough momentum to cause injury to a fellow passenger and damage to a seat. The train 1254 engineer, who was exposed to similar

forces, was in a compartment containing knobs, handles, and switches, several of which could become potential sources of blunt force trauma in a collision. The Armed Forces Institute of Pathology (AFIP) report states that the cab car driver received multiple blunt force injuries, including fatal injuries to his head and lacerations of his abdominal aorta and spleen during the collision. It concluded that "patterned injuries to the head were associated with multiple skull fractures and extensive damage to the underlying brain tissue." Autopsy reports indicate the engineer sustained a scalp laceration having a circular serrated pattern. Similar patterns were found on a control panel knob above the engineer's windshield. Because no other surfaces having this pattern were found in the operators compartment, it is reasonable to conclude that the engineer's head made contact with this knob. The Safety Board also believes that the engineer's abdominal injuries could have been caused by the brake handle, which was driven rearward by the collision.

Based on the AFIP report findings and the cab car damage, the Safety Board concludes that the fatal injuries of the engineer of train 1254 were consistent with the degree of destruction of occupiable space in the cab car. In 1995, in response to Safety Board recommendation R-93-24, which asked that the FRA conduct a feasibility study of using corner posts to afford occupant protection during collisions, the FRA formed a working group to examine the safety issue of rail car passenger equipment design, including structure. As part of its review, the working group is considering several structural designs and design changes that could mitigate or prevent passenger car intrusion in future corner-to-corner collisions. When this review is finished, the FRA intends to publish a Notice of Proposed Rule Making (NPRM) outlining the design changes it believes are necessary to enhance passenger and cab car safety.

**Emergency Response**—The NJT police were notified about 8:40 a.m., and arrived on scene 13 minutes later. The accident occurred in

a remote area accessible only by a muddy and narrow dirt road, which made it difficult for emergency responders to maneuver vehicles and caused congestion among arriving vehicles. Following a delay while responders identified the location and jurisdiction of the accident, the emergency response activities proceeded in a timely manner. Although communication was a problem on scene, emergency responders were able to obtain telephones, cellular phones and radios to help coordinate activities. The Jersey City Fire department's hazardous materials unit was able to contain about 50 gallons of diesel fuel and battery acid that spilled into an embankment after the collision, avoiding a possible fire. NJT provided a train and buses to be used to triage and transport passengers. The Safety Board concludes that, overall, the emergency response efforts were timely and appropriate. Further, the Safety Board is encouraged by the emergency agencies' efforts to improve their response capability by purchasing radios that are compatible with the county radio network frequency.

### **NJT's Postaccident Efforts**

In addition to the changes made by its medical services office, the NJT has initiated other measures to improve safety within its railroad system, including the elimination of all night split shifts and the number of compliance checks of crews in outlying areas. It has enacted more stringent disciplinary measures for employees failing to comply with operating rules. Before this accident, the NJT had suspended engineers who passed stop signals for a minimum of 30

days in accordance with FRA regulations. The NJT now requires the engineer to attend a special recertification training class before returning to work. Moreover, it now dismisses any engineer cited for more than one stop signal violation within a 36-month period. The NJT has indicated that it is attempting to expedite a capital program in which all of its rail lines will be equipped for either cab signals or positive train stop by December 31, 1997, and all NJT lines will be equipped with both technologies by December 31, 2001. The Safety Board recognizes and commends the efforts of the NJT to improve its system safety.

The Safety Board has long been an advocate of train control systems and has included positive train separation (PTS) on its list of "Most Wanted Transportation Safety Improvements." A PTS system provides an automatic means of backing up the engineer's actions by monitoring the performance of the engineer and the train when approaching signal or speed restriction limits. Should the engineer or the train fail to apply the proper brake action, the PTS system will assume control, automatically apply the brakes, and stop the train. Had a PTS system been in place on this railroad line, this collision would not have occurred. The lack of PTS is also a major issue in a collision and derailment of a Maryland Rail Commuter train with National Railroad Passenger Corporation (Amtrak) train 29, *The Capitol Limited*, near Silver Spring, Maryland, on February 16, 1996. In its report of that accident investigation, the Safety Board will discuss this issue in greater detail.

# CONCLUSIONS

## Findings

1. Factors related to the weather, the train equipment, the track, and the signal system did not cause or contribute to the collision. Toxicological tests for alcohol and drugs were negative. Train operators had the necessary training and experience to competently perform their duties. No evidence indicates that fatigue was a factor.
2. The engineer of train 1254 consistently failed to report his medical condition to New Jersey Transit contrary to the railroad company's medical testing requirements.
3. The engineer's acquired color vision deficiency caused him to interpret the color-coded *Stop* indication at signal 28E-1 to be either a *Restricting* indication or a *Medium Approach* indication, either of which would have allowed him to proceed past the signal.
4. The fee-for-service physician's failure to comply with the Dvorine nomenclature testing protocol resulted in the erroneous certification of the train 1254 engineer for duty.
5. Federal standards lack testing criteria to ensure that vision tests will be administered uniformly or effectively.
6. The evacuation of passengers from the accident site was not hampered even though the actions of some train crewmembers were less than adequate.
7. The lack of public announcements addressing the passengers' concerns caused them to act independently, evacuate the train, and wander along the tracks, thus potentially contributing to the dangerous conditions at the collision site.
8. The performance of train crewmembers during emergencies could be improved if the NJT included drills and refresher training in its training program.
9. The fatal injuries of the engineer of train 1254 were consistent with the degree of destruction of occupiable space in the cab car.
10. The emergency response efforts were timely and appropriate.

## Probable Cause

The National Transportation Safety Board determines that the probable cause of New Jersey Transit (NJT) train 1254 proceeding through a stop indication and striking another NJT commuter train was the failure of the train 1254 engineer to perceive correctly a red signal aspect because of his diabetic eye disease and

resulting color vision deficiency, which he failed to report to New Jersey Transit during annual medical examinations. Contributing to the accident was the contract physician's use of an eye examination not intended to measure color discrimination.

# RECOMMENDATIONS

As a result of its investigation, the National Transportation Safety Board makes the following recommendations:

## **--To the Federal Railroad Administration:**

Revise the current color vision testing requirements for locomotive engineers to specify, based on expert guidance, the test to be used, testing procedures, scoring criteria, and qualification standards. (R-97-1)

Require as a condition of certification that no person may act as an engineer with a known medical deficiency, or increase of a known medical deficiency, that would make that person unable to meet medical certification requirements. (R-97-2)

## **--To New Jersey Transit:**

Revise your employee emergency response training courses to include simulation drills and develop a refresher training program to reinforce employee skills in emergency procedures. In all emergency training, stress that employees use the public address system as a means to communicate with passengers. (R-97-3)

Inform your employees, especially those in safety-critical positions, of the facts and circumstances of this accident stressing that they must accurately report their use of medications or any changes in their medical condition. (R-97-4)

## **--To the Association of American Railroads:**

Provide your members with information about this accident, specifically explaining acquired vision deficiency and emphasizing the importance of ensuring the color vision requirement. Stress that railroad employees in safety sensitive positions, especially engineers, report their use of medications or any changes in their medical condition to their employer. (R-97-5)

## **--To the Brotherhood of Locomotive Engineers:**

Provide your members with information about this accident, specifically explaining acquired vision deficiency and emphasizing the importance of ensuring the color vision requirement. Stress that railroad employees in safety sensitive positions, especially engineers, report their use of medications or any changes in their medical condition to their employer. (R-97-6)

## **--To the United Transportation Union:**

Provide your members with information about this accident, specifically explaining acquired vision deficiency and emphasizing the importance of ensuring the color vision requirement. Stress that railroad employees in safety sensitive positions, especially engineers, report their use of medications or any changes in their medical condition to their employer. (R-97-7)

**--To the American Public Transit Association:**

Provide your members with information about this accident, specifically explaining acquired vision deficiency and emphasizing the importance of ensuring the color vision requirement. Stress that railroad employees in safety sensitive

positions, especially engineers, report their use of medications or any changes in their medical condition to their employer. (R-97-8)

**BY THE NATIONAL TRANSPORTATION SAFETY BOARD**

**JAMES E. HALL**  
Chairman

**ROBERT T. FRANCIS II**  
Vice Chairman

**JOHN A. HAMMERSCHMIDT**  
Member

**JOHN J. GOGLIA**  
Member

**GEORGE W. BLACK**  
Member

**March 25, 1997**

# APPENDIXES

## APPENDIX A

### Investigation

The National Transportation Safety Board was notified at 10:28 a.m., eastern standard time, on February 9, 1996, of a collision and derailment involving two New Jersey Transit commuter trains near Secaucus, New Jersey. The investigator-in-charge and other members of the Safety Board investigative team were dispatched from the Washington, D.C. office, and from the Atlanta, Georgia, and Los Angeles, California, field offices. Investigative groups were established to study operations, track,

signals, mechanical, survival factors, and human performance.

The Safety Board was assisted in the investigation by the Federal Railroad Administration, New Jersey Transit Railroad, Brotherhood of Locomotive Engineers, United Transportation Union, New Jersey Transit Police, Jersey City Emergency Medical Services, Jersey City Fire Department, and the Hudson County Emergency Management.

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## APPENDIX B

### Train 1107 Engineer Personnel Information

**General**—At the time of the accident, the 47-year-old engineer of train 1107 had been employed by NJT for 7 years. He had been promoted to locomotive engineer on December 24, 1990, and had been recertified on December 20, 1995, receiving an operating evaluation rating of 3, or “Standard,” on a scale of 5, and an efficiency test rating of 97.6 percent. He had passed his last rules examination, which had been administered on November 7, 1995. He had no disciplinary record and had been designated as an instructor engineer. He had worked the same shift, Monday through Friday from 5:50 a.m. to 1:20 p.m. since January 10, 1996. His assignment required him to report to Hoboken Terminal, complete four train movements, and mark off duty at Hoboken Terminal.

**Duty/rest Schedule**—The engineer’s spouse provided the following history of her husband’s activities (table 6) for the 3 days before the accident. She said that it was his habit to go to bed about 9 p.m. and to arise for work between 4:30 and 4:45 a.m.

**Medical History**—The engineer’s last NJT medical examination was on December 8, 1995, 2 months before the accident; he was

found medically qualified, without restriction, for duty. Records of the eye examination indicate that his visual acuity was 20/40, corrected to 20/20, with normal color vision.

On his medical history form, he reported that he had used Proventil for bronchial asthma during the previous 60 days, and that he suffered no other chronic or acute illnesses since his previous examination on December 8, 1994. NJT records indicate that on November 16, 1995, he had received a random drug/alcohol test, which was negative.

According to his spouse, he was an active person and was in excellent health, although he had experienced asthma since childhood. She said that he occasionally used an inhaler, which he carried with him. Investigators found an oral inhaler containing 200-17g metered aerosol inhalations of Schering Proventil (Albuterol) in his briefcase aboard train 1107. She also stated that he did not use tobacco products, occasionally drank beer, ate a normal diet, and did not use other prescription medications or illicit drugs. She said that her husband had normal hearing, and had been prescribed glasses for driving about 2 months before the accident.

**Table 6—72-Hour Work/Rest History for the Train 1107 Engineer**

Date	Activity
February 6	At home between 2 p.m. and 7 p.m., at which time his wife went out and left him at home. Was asleep when she returned between 10 and 10:30 p.m.
February 7	Departed for work before wife awoke at 6:45 a.m. Returned home from work at 6 p.m. Ate dinner between 6:45 and 7 p.m., at which time wife went out shopping. Was asleep when wife returned home at 8:30 p.m.
February 8	At home from 3 to 7 p.m., ate dinner, and went to bed between 8 and 9 p.m.
February 9	Departed for work before wife awoke at 9 a.m.

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## APPENDIX C

### The Dvorine PIP Testing Protocol Instructions

The Dvorine Pseudo-Isochromatic Plates consist of two sections. Section one contains one demonstration plate (number 48 in red on a blue background) and 14 plates made up of eight different color combinations arranged in pairs of identical colors.

Section two contains one demonstration plate (a blue trail on a red background) and 7 plates featuring trails instead of digits; each of these plates consists of different color combinations, but similar to the color combinations of the first section. The second section may be used to test pre-school-age children and illiterates, or as a corroborative test when an individual fails to identify the plates of the first section.

Best results are obtained when the illumination of the plates approximates that of daylight. A Macbeth Easel Lamp or a Daylight Fluorescent Tube will give satisfactory results. When these are not available, a 100-watt blue-daylight bulb should be used.

The plates are to be held about 30 inches in front of the patient. After being shown the red number 48 of the demonstration plate, the patient is instructed to call off the numbers of the 14 plates that follow. No more than 5 seconds are allowed for the identification of each plate; and hesitant, studied responses, or tilting and turning of the head should be noted and recorded. Behavior of this nature is generally associated with defective color vision.

A similar procedure is to be followed when the second section is used, with one exception. The patient should be furnished with a thin brush or other non-scratching pointer and

directed to outline or trace the trail on the demonstration plate and seven trails that follow it.

#### Nomenclature Test

Test the individual for his knowledge of names of colors by rotating the disk to expose each of the eight circles of color. The responses, both to saturated and unsaturated colors, should be recorded.

If an individual names the colors on the disk correctly but fails the general color test, he still is to be classified as color blind; for many color blind individuals learn to name the colors correctly by their brightness instead of their hue.

Occasionally, an individual may pass the color discrimination test but fails to name correctly the colors of the circles on the rotating disk. This indicates that he is not color blind but that his knowledge of color names is faulty.

#### Estimating The Degree of Color Vision Defect

The quantitative classification table is based on a statistical analysis of 800 highly motivated individuals examined with the DVORINE PSEUDO-ISOCHROMATIC PLATES. This method of estimating the degree of color-blindness rests on the assumption that the more errors an individual makes on this test the more serious is his defect. This assumption is particularly applicable to the DVORINE PLATES because the test samples a wide range of confusion colors and has available published research data.

QUANTITATIVE CLASSIFICATION TABLE

<b>Number of Plates Missed</b>	<b>Degree of Color-Blindness</b>	<b>Expected Percentages</b>	<b>Degree of Handicap</b>
0 to 2	Normal	89.5	No handicap, Acceptable
3 to 4	Borderline	3.0	Mild handicap. May improve score on retest. Acceptable
5 to 11	Moderate	2.0	Moderate handicap. May be employed in occupations where critical color judgment is not essential. Not acceptable for civil aviation.
12 to 14	Severe	5.5	A definite handicap and hazard to industrial and military occupations. Not acceptable of civil aviation.

## APPENDIX D

### Excerpts from New Jersey Transit Rail Operations Timetable No. 9 Special Instructions

The NJT “Emergency Evacuation Procedures” under the subsection entitled “General Information” defines CRITICAL EMERGENCY as:

Imminent danger to life including fire, fumes, smoke, bomb threats, or injuries. Critical emergency evacuation authority: In the event of a CRITICAL EMERGENCY, the chain of responsibility for making the decision to evacuate passengers from a train will be made by the employee in charge as indicated below:

- a. Conductor
- b. Engineer
- c. Crew member
- d. Transportation Department Supervisor
- e. NJ Transit Police Officer
- f. Other railroad management personnel
- g. Other railroad employee

The employee taking charge during an emergency will remain in charge until relieved by a company official designated by the Director of System Operations or his representative.

The subsection entitled “Responsibilities” describes the actions that personnel should take during an evacuation. Part B, Crew Members Or Other Employees, states, in part:

1. The safety of passengers must be the primary concern. Passengers must not be evacuated from a train without authority of the Director of System Operations or his representative, except in a CRITICAL EMERGENCY. When handicapped, elderly or other passengers who are unsure of their footing are

among those to be evacuated from a train, crew members must give them special assistance.

2. During an EMERGENCY or CRITICAL EMERGENCY, train and engine crew members must immediately provide the required flag protection.

3. Trains on adjacent tracks must be stopped before evacuating passengers across such track.

4. Crew members must immediately take charge of the situation, making announcements to passengers and giving them appropriate instruction in order to avoid panic.