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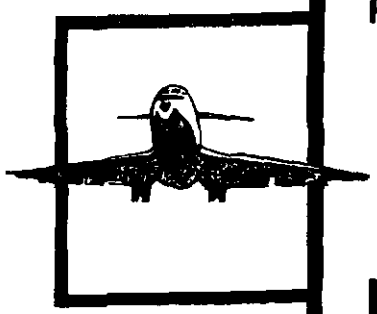

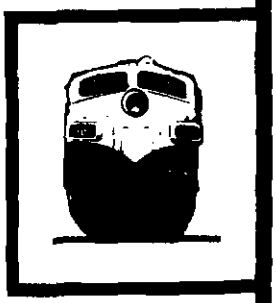

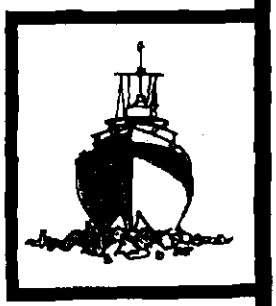

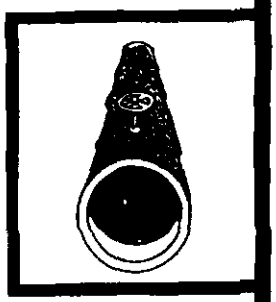

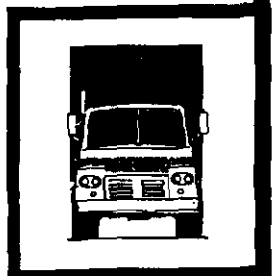

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD / HIGHWAY ACCIDENT REPORT

COLLISION OF A SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY COMMUTER TRAIN WITH A GASOLINE TRUCK
SOUTHAMPTON, PENNSYLVANIA
JANUARY 2, 1982

NTSB-TSR-RHR-82-3

UNITED STATES GOVERNMENT

NTSB-TSR-RHR-82-3	PB82-917005	
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7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 3471A 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Railroad/Highway Accident Report January 2, 1982 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

About 9:45 a.m., e.s.t., on January 2, 1982, eastbound Southeastern Pennsylvania Transportation Authority (SEPTA) passenger train No. 114, consisting of a single rail diesel self-propelled passenger car (RDC), struck a southbound Atlantic Richfield Company (ARCO) Tractor/cargo-tank semitrailer (truck) carrying gasoline at the Second Street Pike crossing at Southampton, Pennsylvania. The tractor and trailer overturned, erupted in fire, and crushed the rear of a automobile standing south of the crossing in the northbound lane of Second Street Pike. Five persons sustained minor injuries. The train operator sustained second and third degree burns over 80 percent of his body and died 2 weeks later as a result of his injuries. Damage was estimated at $452,900.

The National Transportation Safety Board determines that the probable cause of this accident was that the rail diesel car did not maintain a constant shunt of the track circuit, which resulted in the failure of the automatic crossing warning device to indicate to highway traffic the approach of the train.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD/HIGHWAY ACCIDENT REPORT

Adopted: October 19, 1982

COLLISION OF A SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY COMMUTER TRAIN NO. 114 WITH A GASOLINE TRUCK SOUTHAMPTON, PENNSYLVANIA JANUARY 2, 1982

SYNOPSIS

About 9:45 a.m., e.s.t., on January 2, 1982, eastbound Southeastern Pennsylvania Transportation Authority (SEPTA) passenger train No. 114, consisting of a single rail diesel self-propelled passenger car (RDC), struck a southbound Atlantic Richfield Company (ARCO) tractor/cargo-tank semitrailer (truck) carrying gasoline at the Second Street Pike crossing at Southampton, Pennsylvania. The tractor and trailer overturned, erupted in fire, and crushed the rear of a automobile standing south of the crossing in the northbound lane of Second Street Pike. Five persons sustained minor injuries. The train operator sustained second and third degree burns over 80 percent of his body and died 2 weeks later as a result of his injuries. Damage was estimated at $452,900.

The National Transportation Safety Board determines that the probable cause of this accident was that the rail diesel car did not maintain a constant shunt of the track circuit which resulted in the failure of the automatic crossing warning device to indicate to highway traffic the approach of the train.

INVESTIGATION

The Accident

Shortly after 8:10 a.m., on January 2, 1982, the operator (engineer) and conductor of Southeastern Pennsylvania Transportation Authority (SEPTA) train No. 115 performed an air brake test on single rail diesel, self-propelled passenger car (RDC) No. 9164, at Newtown, Pennsylvania, the eastern terminal of the Fox Chase Rapid Transit Line. No problems were noted. At 8:20 a.m., the train proceeded westbound en route to Fox Chase.

About 8:30 a.m., train No. 115 stopped at Southampton Station, immediately north of the Second Street Pike crossing. According to the conductor, the crossing warning device flashers were working. However, from his vantage point, he could not see the indication of the highway traffic signals, which are interconnected with the crossing flashers. A motorist driving south on Second Street Pike reported that, at the time, the traffic signals indication at the crossing was red. After the motorist stopped at the red indication, it turned green for a few seconds, and then turned red again; the railroad grade crossing warning device flashers were not working. The motorist then looked east along the track and saw the train pulling into the station. When the motorist looked ahead, the flashers were working.

Train No. 115 arrived at Fox Chase about 8:57 a.m. The operator changed operating ends and, with the help of the conductor, made another test of the airbrakes on the car; no problems were noted. About 9:30 a.m., the train, operating as train No. 114, departed Fox Chase for its eastbound return trip to Newtown. As train No. 114 approached Second Street Pike crossing for its 9:49 a.m. scheduled stop at Southampton Station, the conductor was at the rear of the car preparing to load and unload passengers at the station's platform, when the train was about 500 feet east of the crossing. The conductor said he heard the train's whistle sounding about one-fourth of a mile before the crossing, and then noticed that the train had slowed down to about 10 miles per hour when it reached the crossing.

About the same time, a 1979 Oldsmobile was northbound on Second Street Pike, south of the railroad crossing. The driver stated that as he approached the crossing, the highway traffic signal was green and the railroad crossing flashing light signals were not flashing. However, he stopped between the Knowles Road intersection and the railroad crossing because he saw the train coming at a slow speed from his left and heard the train's whistle sounding.

Meanwhile, a cargo tank semitrailer, transporting 3,100 gallons of regular gasoline and 4,800 gallons of unleaded gasoline, was traveling east on Street Road, State Route 132. The truck, owned and operated by Atlantic Richfield Company (ARCO), stopped at the traffic signal at the intersection of Street Road and Second Street Pike and then turned right (south) onto Second Street Pike toward the railroad track. As the truck approached Belmont Avenue, which enters Second Street Pike from the west, about 380 feet north of the track, an automobile pulled past the intersection stop line painted on the pavement and stopped. The truckdriver stated that he touched the brake and pulled to the left, but not into the left lane, and diverted his attention to the right rear view mirror to make sure the trailer tandem wheels cleared the automobile. He said that when he looked ahead again, the traffic signal north of the crossing was green and the railroad crossing flashing light signals were not flashing. He proceeded into the crossing about 20 to 25 miles per hour (mph) in third gear. When the truck was on the crossing, he heard the train's whistle (the left side window of the tractor was open about three fourths of an inch), and then he looked up and saw the train coming from his right. He started to swerve into the left lane; however, because there was an automobile in the lane, he straightened out the truck and kept moving, hoping the train would not hit the trailer. (See figure 1.)

About 9:45 a.m., train No. 114 struck the trailer. The tractor-trailer combination overturned to the left and came to rest in a jackknifed position with the trailer on top of the rear of the automobile in the left lane. A fire erupted and flames engulfed the tractor trailer and the automobile. (See figure 2.) The truckdriver opened the left door of the truck about 18 inches and, after unfastening his seatbelt, crawled from the cab on his back, assisted by a passerby. The driver of the Oldsmobile kicked open the door on the driver's side and walked away from the fire.

When train No. 114 stopped, its front end was over the east end of the crossing and its rear end was over the west end of the crossing. (See figure 1.) The front truck was derailed to the right.

The conductor who had been thrown to the floor by the impact, led the passengers off the train and shut off the emergency fuel valve in the conductor's cab. He tried to go forward to the operator's position but was unable to do so because of the fire. The conductor then went to a photo store on the northside of the crossing to call for help. At

Figure 1.—Area of accident.

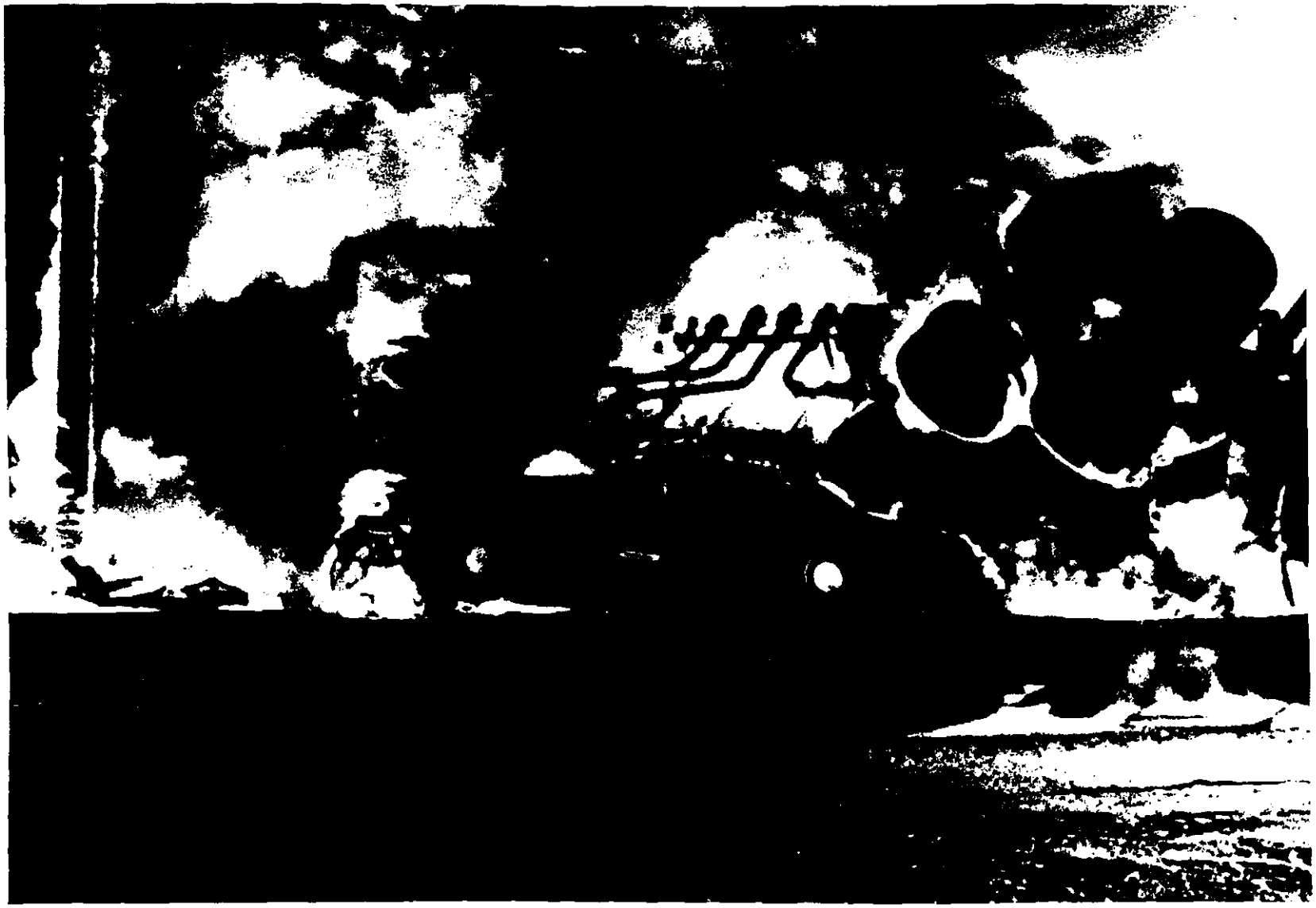


Figure 2.—Truck and automobile engulfed in flames.

that time, he noticed that the crossing flashers were working, but he did not notice the indication of the highway traffic signals for the intersection about 60 feet south of the crossing.

A pedestrian walking north on the west side of Second Street Pike in the vicinity of Belmont Avenue said he heard the train's whistle and saw the railroad crossing signal lights flashing. He did not notice the aspect of the highway traffic signal. Several seconds later he saw the truck pass Belmont Avenue going south on Second Street Pike at a slow rate of speed and later heard an explosion.

The driver of a vehicle in the driveway south of Second Street Pike opposite Knowles Road was stopped at the highway traffic signal prepared to turn left into Second Street Pike. He said he heard the train coming east and saw the highway traffic signals turn red for Second Street Pike and Knowles Road briefly and then saw the highway traffic signal turn green for Second Street Pike. He saw a northbound car proceed through the Knowles Road intersection and stop short of the track. He then saw the truck south on Second Street Pike, proceeding slowly onto the railroad crossing. When the witness saw the train strike the cargo tank and the truck burst into flames, he backed up and moved away from the fire.

The driver of a vehicle traveling southbound about 20 to 25 mph on Second Street Pike, and about 75 feet behind the truck, estimated the truck's speed at about 15 mph. He did not see the railroad crossing signal lights flashing before the accident, but he heard the train's whistle. He said that he did not see the indication of the highway traffic signal nor see the crossing signals flashing after the accident.

Emergency Response

An Upper Southampton Township Police Officer on patrol on Second Street Pike near Belmont Avenue north of the track heard the train horn blow once, and immediately after that heard a large loud crunching sound. He turned around to investigate and saw flame and smoke in the area of the SEPTA train tracks on Second Street Pike. After calling the dispatcher and requesting that the Southampton Fire Company respond to the scene, the patrolman proceeded to the scene. As he tried unsuccessfully to extinguish the train fire with his portable extinguisher, he saw the train operator lying on the ground in front of the train, badly burned. He ran to the rear of the train and saw the remnants of a tractor/trailer with a car under it fully engulfed in flames. He returned to his vehicle and requested additional fire and police support and an ambulance. In addition to noticing that the overhead electric wires were burning and flames were moving closer to the gasoline station located at Knowles Avenue and Second Street Pike, he saw a large column of flame and smoke rising from the storm sewer 150 yards from the crossing, behind a furniture store in the northwest quadrant. He therefore requested additional help from the electric company and the fire companies and then returned to the scene.

About 9:45 a.m., the fire chief at the Southampton Volunteer Fire Department, Station No. 2, saw a large black smoke cloud in the vicinity of the Southampton railroad station. The fire chief thought the fire might have been at the fuel oil storage facility site on Knowles Avenue. A driver at the station radioed the county dispatch center for authority to be dispatched to the unknown fire near the station located at Knowles Avenue and Second Street Pike. Two engines, a snorkle truck, and a heavy rescue truck were dispatched to the scene. As the fire chief approached the scene coming down Knowles, heading toward Second Street Pike, he saw a large volume of fire, the rail car on fire, and fire in the storm sewer. At 9:50 a.m., he sent out a second alarm. Northampton

Station No. 3 responded with four engines, a ladder truck, and a rescue truck. After hoses were laid, he was notified of the operator underneath the train. Three firefighters rescued the train operator and placed him in the ambulance.

The fire chief ordered hose attacks on nearby exposed structures. Shortly afterward, the patrol officer notified the fire chief that everyone had been evacuated from the train. The fire chief said that he saw smoke on the ground in front of the train, and although he did not see fire (flames) on the train, he did observe smoke through the windows. About that time, the second alarm company arrived on the scene and immediately went into the train car for a primary search. At 9:56 a.m, the fire chief called a third alarm, and the dispatcher ordered additional units to the scene.

Fire covered the entire intersection. Burning gasoline ran from the cargo tank, toward a curb storm drain about 88 feet from the cargo tank. Once in the 24-inch concrete underground storm pipe, it flowed northwesterly 350 feet downgrade to a catch basin and burned in a 150-foot open area downstream of the discharging pipe. Within the first 2 minutes, witnesses observed underground explosions from the culverts and saw fire venting from the open grating covers north of the crossing. (See appendix G.) During the first 20 minutes, about 500 people were evacuated from the area by police.

During the first hour, a command post was set up in the parking lot beside the railroad station. The fire chief decided to allow the vehicle fires to continue to burn and consume the released gasoline to protect nearby exposures. Between 11:00 a.m. and noon, fire crash rescue units from the Willow Grove Naval Air Station and Warminster Naval Air Development Center extinguished the vehicle fires with light water and poured foam into the underground storm drains to smother the gasoline fire. By noon, the Southampton Fire Department constructed several dikes to contain the excess gasoline runoff. Between 3:00 p.m. and 4:30 p.m., ARCO personnel siphoned 200 gallons of remaining gasoline residues from the wreckage into an ARCO tractor/cargo-tank semitrailer.

Injuries to Persons

	Train No. 114			1979		
	Crewmembers	Passengers	ARCO Truck	Oldsmobile	Others	Total
Fatal	1*	0	0	0	0	1
Minor	1	3	1	1	0	6
None	0	0	0	0	0	0
Totals	2	3	1	1	0	7

* The train operator died 2 weeks later as a result of injuries sustained during the accident.

Damage to Vehicles

Train No. 114.--Impact damage to RDC No. 9164 was limited to the right front corner and the forward passenger compartment. (See figure 3.) The right crash post of the front door, the right front panel, the right front side door, and the right front steps of the RDC were bent to the right and back. The right front panel was bent inward in a semi-circular shape with the deepest penetration, over 31 inches, about 7 feet 6 inches above the rail. The front pilot was torn off. The front buffer and front coupler were unmarked and undisturbed. The end sill was bent inward. The control stand and its associated piping and wiring were dislodged and destroyed. The front passenger carrying compartment sustained extensive fire damage. SEPTA considered the car destroyed

Figure 3.—View of right front corner of RDC 9164.

because of the fire damage to the car's wiring, although the structural damage was repairable. Damage to the car was estimated at $385,000. 1/

ARCO Truck.--Except for the two front tires, the right fender and door, the body of the Mack tractor was damaged extensively by the rollover and fire. The left rear of the cab was pushed forward and downward. The tractor cab interior was gutted by fire and all the cab window glass was destroyed. The tacograph, rear tires, wiring, and air hoses to the brake chambers, except at the right front, were destroyed by fire. (See figure 4.)

Most of the cargo tank was separated from its tandem assembly, except for a bottom piece 3 feet long, which contained the tank's rear internal shutoff valve. The right side bottom loading and delivery valve, which was contained in an angle iron open rack, was also ripped from the cargo tank shell. The right side of the first four baffle sections of the tank's first compartment was torn and destroyed by fire two-thirds from the bottom center of the tank, and from the fourth section of the first compartment to the rear of the tank. The entire right side of the tank was torn and destroyed by fire, leaving only the left side with about one-fourth of the tank intact. A large portion of the rear section of the cargo tank was missing as a result of fire damage.

The tandem subframe, at the rear of the right front spring hanger, had an inward vertical crease and a downward buckling. The right front outside and inside wheels were gouged severely in the inside of the tire. A 9- by 3-inch tear was found on the outer rim of the inside wheel. The right center spring hanger bolts were sheared, causing the right side tandem wheels to deform rearward. Damage to the ARCO tractor semitrailer and its cargo was estimated at $50,000 and $7,900, respectively.

1979 Oldsmobile.--The automobile was destroyed by fire. The roof of the vehicle was crushed downward and all the doors were deformed, except for the driver's door. Damage was estimated at $7,000.

Other Damage

Gouge marks 43.3 feet long in the crossing timbers were found 2 feet 4 inches south of both rails near the middle of the southbound lanes of Second Street Pike. The marks extended through the crossing pavement and beyond the east curbline of the Pike.

The highway traffic signal between the railroad track and Knowles Avenue, east of Second Street Pike, was overturned, and its associated circuitry was destroyed by the fire. Damage was estimated at $5,000. An electric power company pole, adjacent to the highway traffic pole, and the transmission wires were damaged by the fire. Damage was estimated at $3,000. A lumber yard sign in the northeast quadrant of the intersection between Knowles Avenue and Second Street Pike and a gas station sign in the southeast quadrant of the intersection were burned. Damage was estimated at $2,000.

Personnel Information

SEPTA Crewmembers.--The operator, 42, was employed by SEPTA as a trackman on April 30, 1973. He transferred to the operating department later in 1973 and became qualified as an operator on the Broad Street subway line. He qualified as an operator of

1/ The rail diesel car and ARCO truck were examined after they had been removed from the derailment scene. The exact point of impact could not be determined nor the exact damage caused by the accident as opposed to that caused by the removal of the equipment.

Figure 4.—Accident view looking north on Second Street Pike from Knowles Road Intersection.

self-propelled electric multiple unit cars on SEPTA's Rapid Transit Fox Chase Line on October 5, 1981. His last physical examination by a company physician was performed on August 28, 1981, at which time he was approved for service. During the 7 days before the accident, he worked as an operator on the Fox Chase Rapid Transit Line between 10:45 a.m. and 8:35 p.m., daily. There was no service on the line on January 1, 1982.

The operator received the following training for operation of RDC equipment on the Fox Chase Rapid Transit Line in 1981:

Aug. 31 - Sept. 11 (9 days)	- Instruction on Book of Rules
Sept. 12 - Sept. 15 (2 days)	- Review and written examination on Book of Rules
Sept. 16 - Sept. 18 (3 days)	- Instruction on airbrake rules and equipment including on-hands operation
Sept. 25	- Review and written examination

The conductor, 38, was employed by SEPTA on the Broad Street Subway Line in March 1978 as a conductor and operator. He also qualified at the same time as an operator on the Fox Chase Line and received the same training as the operator.

ARCO Truck Driver.--The truckdriver, 47, had been employed with the ARCO refinery since January 1962. In June 1972, after attending a 4-week driving school, he started delivering heating fuel, diesel fuel, and gasoline. He had been delivering ARCO products to the Southampton area about twice a month during the past year.

A review of his driving record indicated on February 4, 1981, he received 2 points for driving too fast for road conditions. He received a summons on June 25, 1981, in Avalon Borough, Cape May County, New Jersey, for driving while intoxicated. The New Jersey courts suspended his driving privilege for driving a private vehicle while intoxicated in the State of New Jersey but restored it on October 11, 1981. His driving record in Pennsylvania did not indicate this suspension, and his driving privileges in Pennsylvania were therefore not affected by the New Jersey suspension. There is no reciprocity between the two states concerning driving records. 2/ During January 1982, he received a 7-year safe driver award from ARCO because of no accidents involving his driving an ARCO truck. ARCO is an interstate carrier and is subject to the Federal Motor Carrier Safety Regulations (FMCSR). These regulations state the motor carrier must consider the driver's record and any evidence of violation of laws governing the operation of motor vehicles. (See appendix B.) ARCO requires its drivers to report any driving violation received while operating a company or privately-owned vehicle. ARCO

2/ In 1980, the Safety Board issued "Safety Effectiveness Evaluation of Detection and Control of Unsafe Interstate Commercial Drivers Through the National Driver Register, State Driver Licensing Policies, and the Federal Motor Carrier Safety Regulations" (NTSB-SEE-80-1), February 15, 1980. In the report, the Safety Board encouraged the use of the National Driver Register to disqualify drivers that exhibit unsafe practices, and it encouraged States to have reciprocity agreements. The Safety Board recommended that the FHWA: "Revise the commercial driver disqualification provisions of the Federal Motor Carrier Safety Regulations to provide that the specified disqualifying driving offenses shall be disqualifying without regard to the type of highway vehicle driven at the time of the offense or whether the driver was on or off duty" (H-80-16). The FHWA recently issued an ANPRM to respond to this recommendation.

annually reviews the Pennsylvania driving records of its drivers; however, the company does not review the records of other States not having reciprocity agreements with Pennsylvania.

Track and Highway Grade Crossing Information

Track.--The Fox Chase Rapid Transit Line is a single track which extends from Fox Chase, Pennsylvania, to Newtown, Pennsylvania, a distance of 15.2 miles. The track crosses Second Street Pike about 60 feet north of Knowles Avenue. The angle of the intersection between the track and Second Street Pike in the northwest quadrant is about 132 °. The track is straight for about 1 1/2 miles west of the crossing on an 0.8 percent ascending grade.

The Southampton Station is located about 200 feet east of the crossing, and its platform extends along the north side of the track from a point about 50 feet east of the curbline of Second Street Pike. A building located in the northwest quadrant, about 33 feet north of the track, limits a train operator's view of southbound traffic on Second Street Pike. (See figure 5.)

Two automatic railroad crossing flashing light signals are located within the railroad right-of-way. One signal is located in the northwest quadrant, cantilevered over the center of the right southbound lane of Second Street Pike. The second signal is mounted on a post in the southeast quadrant. Both signals are back to back, and are aimed north and south on Second Street Pike.

The flashing signal system was installed in accordance with a standard double rail signal circuit approved by the Association of American Railroads. It uses a 3,300 ampere-hour battery, direct current, type track circuit with a 4-ohm relay of the type manufactured by the Union Switch and Signal Company and the General Railway Signal Company. An eastbound train or locomotive activates the signals when a shunt is established by its wheels making contact with both rails of the track after the locomotive or engine passes the insulated joints located 1,990 feet west of the crossing. When the wheels of a train or locomotive make contact with both rails, the track current flows through the wheels and axles, rather than from the rails to the relays in the relay box at the crossing; when this occurs the relays become deenergized and the flashing light signals are activated. (See figure 6.)

Although it is not required to do so, SEPTA complies with Federal regulations regarding signal and track inspections and maintenance. The last monthly inspection of the automatic railroad grade crossing protection was conducted on December 3, 1981. The last quarterly relay inspection of the railroad grade crossing protection was conducted on October 5, 1981. Track inspections are made twice weekly. The last track inspection was made on December 31, 1981.

Highway.--The Second Street Pike is a 4-lane, 39-foot wide highway, which generally runs north and south. The highway is straight for about 1,000 feet north and south of the railroad crossing. A driveway to the back entrance of the Southampton Shopping Center intersects with Second Street Pike from the west, opposite Knowles Avenue. The surface of the highway is asphalt and appears to have been worn. The 4-inch "barrier" curbs and the sidewalks are concrete. The track rails are bordered by single timbers, one on each side of each rail, with asphalt between the timbers in the gage of the track. The roadway approaches the railroad from the north on a vertical curve that results in about a 1/2 percent ascending grade and is almost level through the crossing.

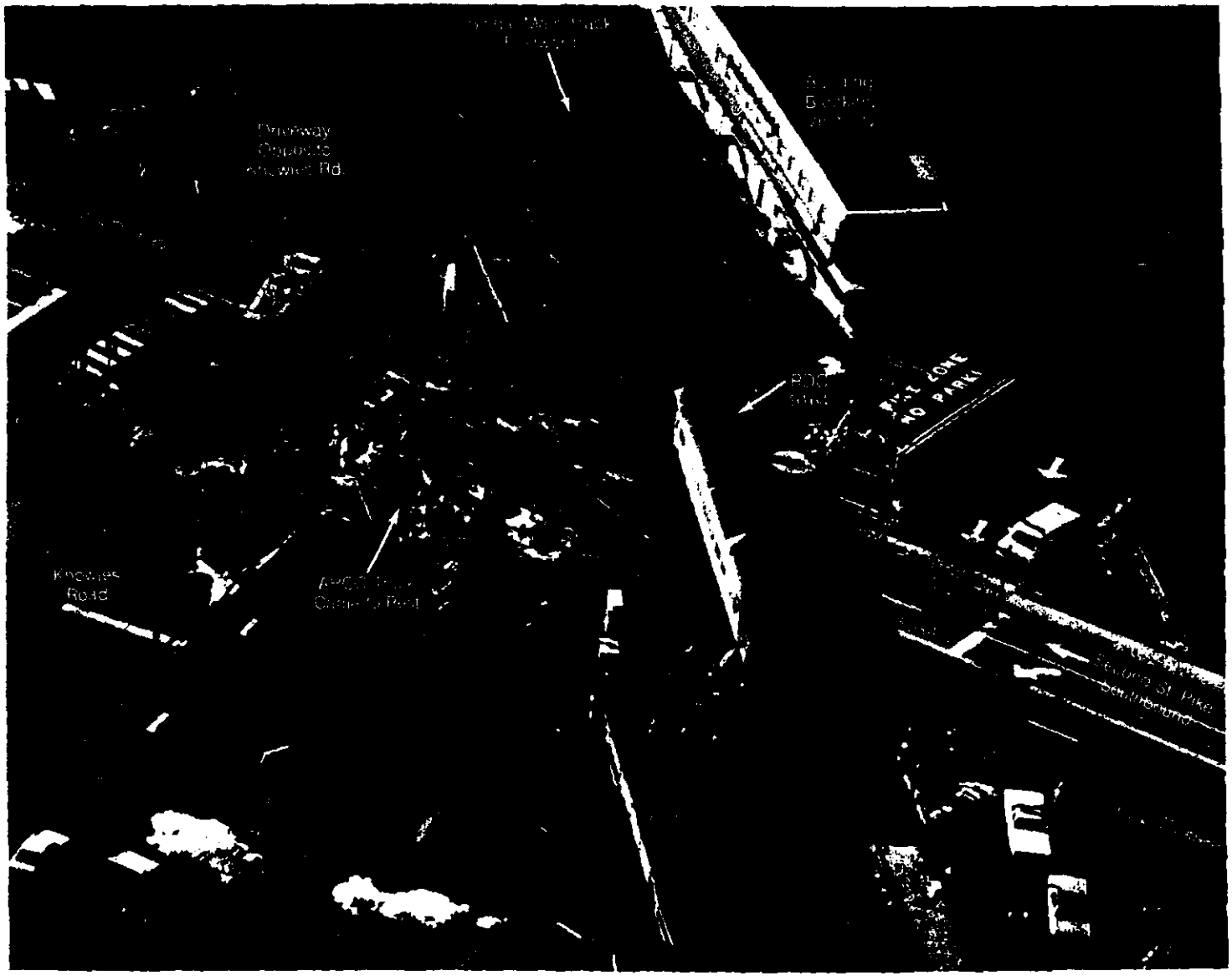
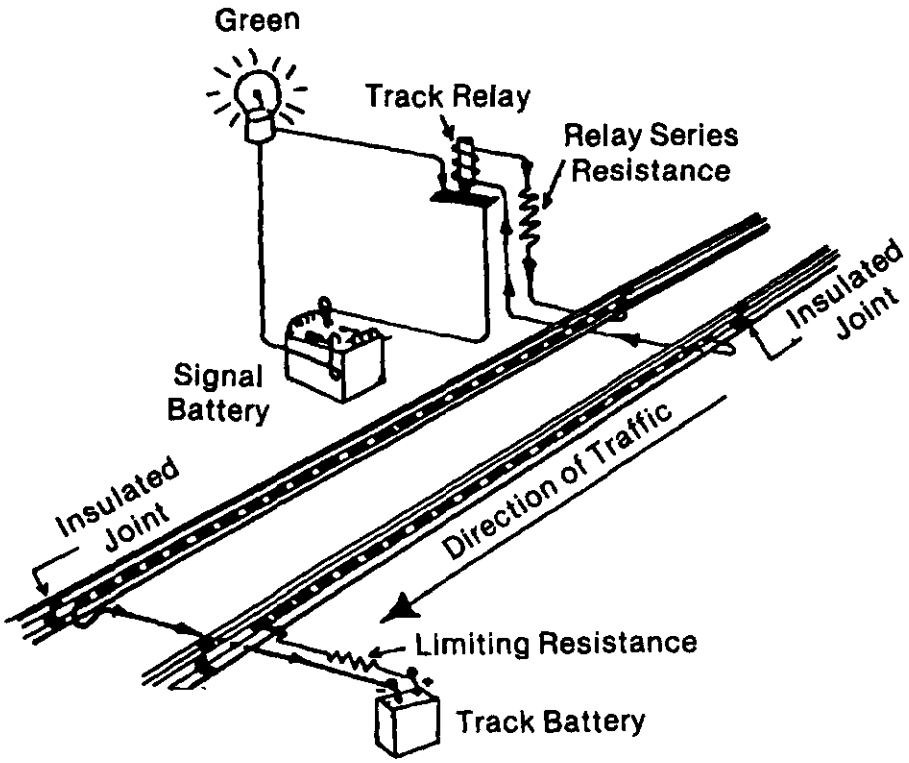
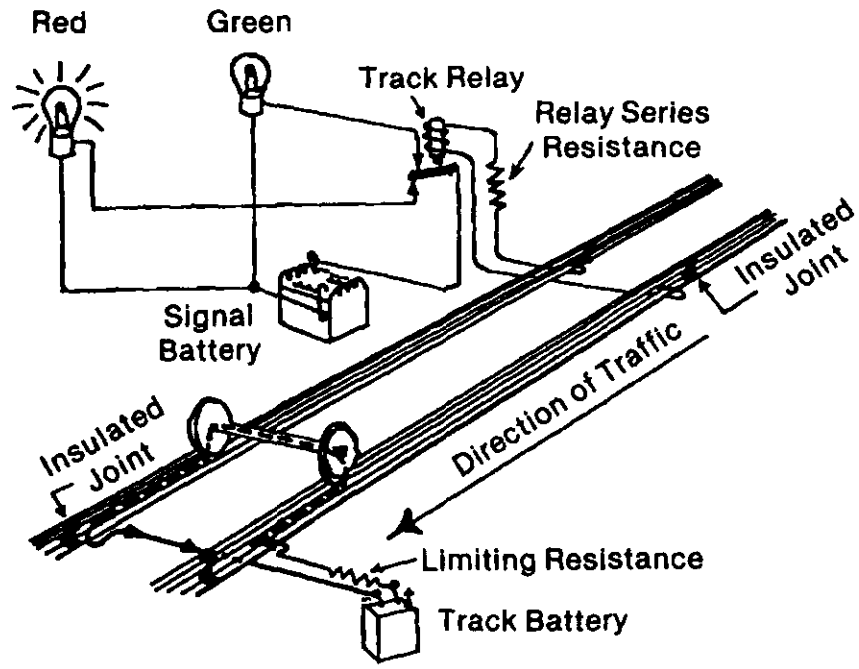


Figure 5.—Aerial view of accident area.



Unoccupied Track Circuit



Occupied Track Circuit

Figure 6.—Sketch of track circuit shunting.

A three-lens highway traffic signal is located about 8 feet from the north rail of the track crossing. The signal, which faces north, is mounted on a cantilever arm, 16 feet over the center of the left southbound lane of Second Street Pike. Another three-lens highway traffic center is mounted on the upright of the cantilever arm, 8 feet above the street, at the west curb of Second Street Pike. A white stop bar is painted about 35 feet north of the cantilevered traffic signal, across the two southbound lanes of Second Street Pike with a "STOP HERE ON RED" sign at the west curb. A 25-mph speed limit sign is located about 150 feet north of the highway traffic signals at the west curb with railroad pavement markings that consist of "RXR's" painted on the southbound lanes. At the time of the accident, there was no advance railroad warning sign on Second Street Pike north of the crossing. Highway traffic signals are located on the four corners of the intersection of Knowles Avenue and a shopping center driveway with Second Street Pike south of the railroad crossing. The two post-mounted traffic signals and the centilevered signal south of Knowles Avenue and Second Street Pike are visible also to southbound traffic on Second Street Pike.

The railroad's automatic grade crossing protection system at Second Street Pike provides a normally open contact to the highway traffic signal system. When the railroads grade crossing protection signals are activated, a relay closes the contact and provides a continuous electrical circuit to the highway traffic signals at the crossing. The highway traffic signals were installed under the authority of a traffic signal permit, which was approved by the Commonwealth of Pennsylvania, Department of Highways, on August 6, 1968, and was revised on August 20, 1969. The permit requires 5 post-mounted and mast-arm posts with 12 signal faces. The signal system controller provides a two-phase vehicular cycle and a train phase. (See appendix C.)

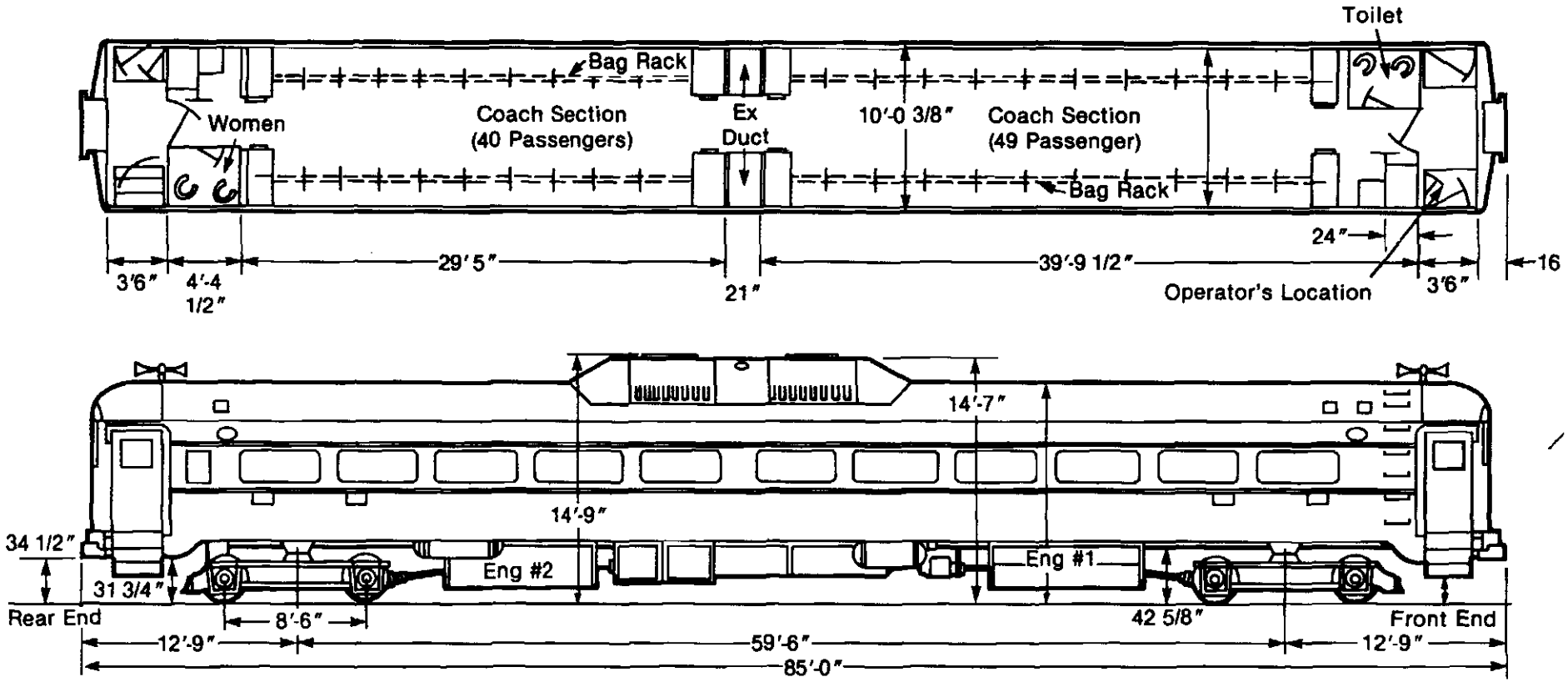
Train Information

RDC No. 9164 was manufactured in 1955 by the Budd Company for the Boston and Maine Corporation and was purchased by the Reading Company in October 1965. The car became the property of SEPTA after the Reading commuter operations was acquired by SEPTA.

The car, powered by a Detroit diesel engine with a hydraulic torque converter drive developing 300 horsepower, was equipped with a 26RL New York air brake system with inboard Budd Company disc-type brakes on the wheels. The car was 85 feet long, 10 feet 4 9/16 inches wide, and 14 feet 9 inches high. The 4-wheel trucks were centered 59 feet, 6 inches apart. The car weighed 118,500 pounds without passengers, seated 89 passengers in walkover seats in a two-by-two configuration, and was divided into two compartments by exhaust ducts on each side of the aisle at the center of the car. (See figure 7.)

The operator's controls were located in 3-foot 5-inch vestibules at each end of the car. A 24 3/4- by 26 1/2-inch window was located about 45 inches above the floor in the forward section of each vestibule. Access to the vestibules from the passenger compartment were through inward opening doors. Steps were located on each side of the vestibule with a trapdoor and side door for access to the steps. To close the inward opening side doors, the trapdoors had to be down and latched. Inward opening doors were also provided at each end of the car to provide access to another car when operating in multiple with other units.

RDC No. 9164 was equipped with headlights, oscillating lights, forward facing horns, and high visibility front panels. A foot pedal engineman's safety control (deadman), which would apply the train's brakes in emergency if not held down, and an emergency fuel cutoff switch were located both inside and outside the car. The car was also equipped with a fire extinguisher and a first aid kit.



Total Weight 118500#

Weight on Drivers 60620#

Figure 7.—Sketch of rail diesel car.

Truck Information

The tractor semitrailer combination was owned and operated by the Atlantic Richfield Company. The 13,474 pound tractor was a 285-horsepower Mack Model R686 ST, 6-cylinder diesel. The tractor was equipped with a Mack TRL1076 transmission with the engine governor set at 1,800 rpm. The tractor was 228 long, 72 inches high at the cab, and was 95.4 inches wide. It had a wheel base of 151 inches. The semitrailer was a 1979 Custom Trailer, Inc., DOT type MC 306 AL specification cargo tank. (See figure 8.)

At the time of the accident, the cargo tank was loaded with 3,100 gallons of regular gasoline and 4,800 gallons of unleaded gasoline, both with a flashpoint of -45° F. The gross combination weight of the truck was 73,000 pounds. Records indicate that the truck was maintained according to Federal regulations.

Method of Operation

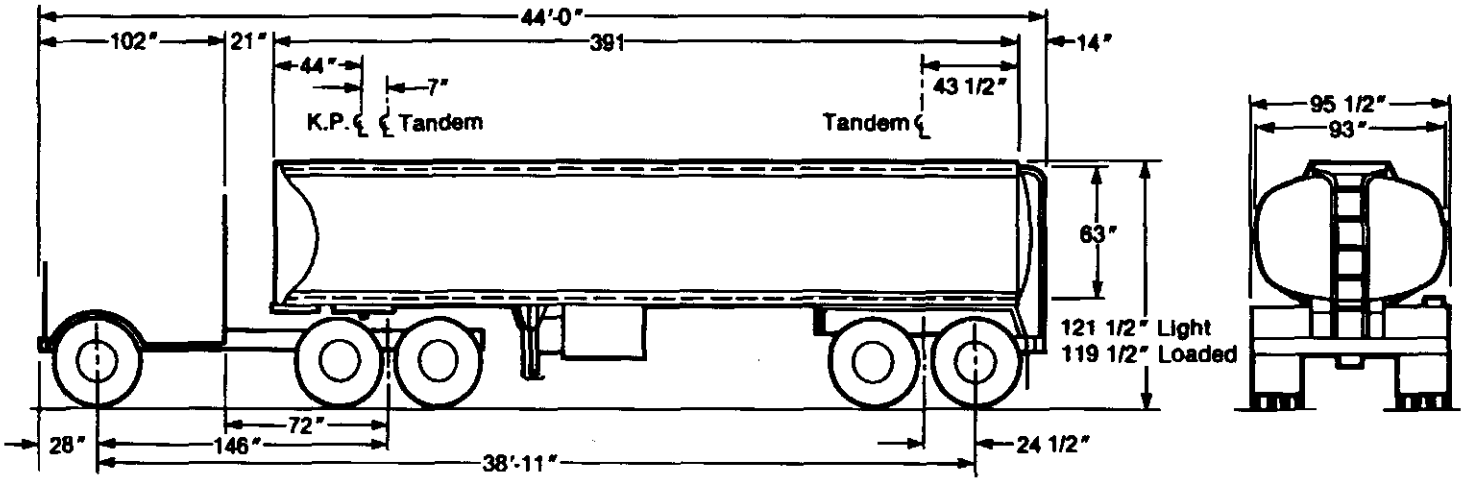
The Fox Chase Rapid Transit Line, which is 15.2 miles long, was part of the Consolidated Rail Corporation (Conrail) Newtown Branch, until SEPTA acquired the commuter properties of Conrail on April 30, 1976. Conrail continued to operate the commuter passenger trains and maintained the properties under contract to SEPTA. Conrail's Newtown Branch was electrified to Fox Chase Milepost 11.1. Service between Fox Chase and Newtown Milepost 26.3 was provided with rail diesel cars. Since Conrail provided service from Newtown directly to the Philadelphia Reading Terminal, normally two coupled rail diesel cars were used to accommodate the passenger load between Fox Chase and Philadelphia. However, Conrail's Timetable Special Instructions did provide for operation of single rail diesel cars similar to those used by SEPTA.

On July 5, 1981, Conrail terminated the service on the branch between Fox Chase and Newtown. SEPTA rehabilitated the line by replacing 9,000 ties and 15 switch timbers, resurfacing the track, and surveying curves for elevation and realignment where required. Whistle posts and mileposts were replaced or reset. At highway grade crossings, bond wires were renewed, and relays were tested and replaced where needed. Experienced managers, supervisors, trackmen, and signalmen were hired from other railroads. Operators and conductors were recruited from SEPTA's Rapid Transit Lines and trained. After the operators' training was completed, revenue service was started on October 5, 1981.

Trains are operated under the rules of a Manual Block Signal System through the accident area. The maximum authorized speed for trains is 40 miles per hour. Trains are required to approach Second Street Pike prepared to stop, unless the train operator knows that the automatic highway crossing protection is working by viewing the lights flashing in a side window of the automatic signals. 3/ If the automatic highway crossing protection is not working, the train operator must ascertain that the crossing is clear before proceeding over the crossing. (See appendix D.)

The timetable direction from Fox Chase to Newtown is eastward. The Second Street Pike grade crossing is 7.88 miles east of Fox Chase. Eight trains are scheduled in each direction, Monday through Friday, and four trains are scheduled in each direction on Saturday. There are no scheduled trains on Sundays and holidays. Since Friday,

3/ A peep-hole in the sides of the railroad grade crossing signal lamp units viewed from an approaching train enables an operator to see the lights flashing when the signal is activated.



1270	Trailer & Load	25240
7100	Tractor	6900
8370	Total	32140

Rayload 7948 Gal at 6.2 Lb./Gal	49280
Trailer	10000
Trailer & Payload	59280
Tractor	14000
Gross Load	73280
Allowable Gross Weight in	73280

Atlantic Richfield Company
Los Angeles, Calif.
8000 + 3% Gal.

Figure 8.—Sketch of truck trailer.

January 1, 1982, was a holiday, there were no trains operating over the Second Street Pike crossing from 5:49 p.m. (eastbound train No. 130) on Thursday, December 31, 1981, to 8:37 a.m. (westbound train No. 114) on Saturday, January 2, 1982.

Only one train is scheduled between Fox Chase and Newtown at one time. Trains are scheduled to interchange passengers with SEPTA commuter trains operated by Conrail between Fox Chase and Reading Terminal, Philadelphia, Pennsylvania. At the time of the accident, all Fox Chase Rapid Transit Line trains were operated with single rail diesel cars.

Traffic Flow and Density.--A September 18, 1976, traffic survey of Second Street Pike, between Knowles Avenue and Keystone Road, indicated that on that Saturday about 17,733 vehicles were counted, of which 1,025 vehicles were observed between 9 a.m. and 10 a.m. The average annual daily traffic was calculated to be 17,731 vehicles by the Pennsylvania Department of Transportation.

Federal Highway Administration (FHWA) regulations require that drivers of motor vehicles transporting hazardous materials stop, look in both directions, and listen before crossing railroad tracks with automatic flasher devices. However, such vehicles are not required by Pennsylvania regulations or the Uniform Vehicle Code (UVC) to stop at grade crossings protected by crossing gates, an alternately flashing light warning of an approaching train, or an official traffic control device displaying a green indication. Because of numerous types of other highway accidents which have occurred when trucks stopped at such crossings, the Safety Board recommended in 1981 that the FHWA amend 49 CFR 392.10 to be consistent with the UVC (safety recommendation H-81-77). (See appendix E.) FHWA regulations currently only exempt such vehicles from stopping at railroad grade crossings controlled by a functioning highway traffic signal displaying a green indication. (See appendix B.)

There are no designated hazardous material or truck routes through the town of Southampton.

Meteorological Information

On January 2, 1982, the Willow Grove, Pennsylvania Naval Air Station (located about 6 miles west northwest of the accident scene) reported the following weather observations:

8:55 a.m., e.s.t., clear, visibility — 7 miles; temperature — 27° F; dewpoint — 10° F; wind direction 330° at 08 knots; total sky cover-0.

9:55 a.m., e.s.t., clear, visibility — 7 miles; temperature — 29° F; dewpoint 12° F; wind direction 310° at 08 knots; total sky cover-0.

On December 31, 1981, and January 1, 1982, it was reported to have rained heavily in the Philadelphia area.

Medical and Pathological Information

The operator of the rail diesel car sustained second- and third-degree burns over 80 percent of his body and minor injuries to his abdomen. 4/ The official cause of his

4/ Autopsy performed at Crozer-Chester Burn Center for Coroner of Delaware County, Pennsylvania.

death on January 16, 1982, was sepsis thermal burns. Because he was heavily sedated during the 15 days after the accident, he could not be interviewed.

The conductor of the rail diesel car sustained a right shoulder injury and a right knee sprain. He was treated and released from a local hospital on the same day.

Two train passengers were taken to local hospitals for treatment of leg injuries and released. The third train passenger received private treatment for an abrasion and contusion of the right leg.

The driver of the ARCO tractor semitrailer was treated for minor burns and released from a local hospital.

The driver of the 1979 Oldsmobile was treated for minor burns about the face and a laceration on his head and released from a local hospital.

Tests and Research

Signal Tests.--Beginning January 2, 1982, SEPTA and later NTSB investigators checked the signaling associated with the railroad flasher light warning system at the accident site. The track was shunted in 20-foot increments with a standard 0.06-ohm shunt; 5/ no failures of the flasher lights were detected. The track voltage measured at the relay was 0.05 volt, an acceptable value.

The dropaway and pickup values of the signal relays were measured and found to be within an acceptable range. The signal relays then were taken to the signal shop, where they again tested satisfactorily. A visual check of the contacts determined that they were in good condition. There is no provision in the circuit to retard the de-energization of the crossing light activation relays if the track shunt is lost momentarily.

Ballast leakage tests were not conducted because excessive leakage would have caused the signals to be activated. A single RDC car was operated over the crossing two times in a test operation on January 11, 1982, and no failures in the automatic operation of the crossing signals were detected.

A review of Conrail's maintenance records before October 1, 1981, indicated that routine periodic testing had been performed regularly. No history of failures or discrepancies were found. SEPTA's maintenance records indicated that it had continued to perform routine periodic testing since October 1, 1981, and the results were satisfactory. No change had been made in the crossing circuit system since SEPTA took over the Fox Chase Line.

Test Train.--When service resumed on the line after the accident, SEPTA operated with two RDC cars as a precautionary measure. Two regularly scheduled RDC trains, Nos. 5 and 2, operated between Newtown and Fox Chase on Monday, January 11, 1982, as test trains with a single car to observe the operation under similar conditions to those on the day of the accident. No service had been operated over the line since train No. 1830 had arrived at Newtown from Foxchase on Saturday, January 9, 1982. This let rust accumulate on the rail for 1 day in the same manner as on January 1, when the track was not used before the accident. The weather conditions were more severe than those at the

5/ The 0.06 shunt is the standard shunt value required by the Rules, Standards and Instructions for Railway signal systems published by the Federal Railroad Administration. However, since SEPTA assumed control of the Fox Chase-Newtown Line from Conrail, this would not be a federally enforced requirement.

time of the accident. There had been snow flurries on January 10, and the temperature had hovered near zero, and at the time of the test, the temperature was about 2° F, with heavy frost. A truck-tractor similar to the one involved in the accident was obtained by the Upper Southampton Police to determine at what point a southbound driver on Second Street Pike could first observe an eastbound train.

Westbound train No. 5 left Newtown at 6:25 a.m., making all stops westbound to Fox Chase. The flashers at all protected crossings operated continuously while the train was on the circuits and while it passed the crossings. The train operator saw well in advance of the crossings that the warning devices were operating properly.

Eastbound train No. 2 left Fox Chase at 7:07 a.m. During its regular run, train No. 2 is not scheduled to make any stops between Fox Chase and Newtown; however, for the purposes of the test, it was arranged for the operator to make a station stop at Southampton in the normal manner. The grade crossing warning devices from Fox Chase to Southampton operated as intended. As the train approached Second Street crossing, the railroad flashing signals operated continuously until the train was through the crossing. The train operator saw the operating flashers about 800 feet before reaching the crossing.

The driver of the truck, who was stopped north of the highway painted stop bar, 35 feet north of the crossing, could see the trains about 400 feet west of the crossing. Conversely, the operators of the trains could see a motor vehicle southbound on Second Street Pike at the same location.

Other Information

Accident History.—A review of the records of the Commonwealth of Pennsylvania indicated that seven accidents had occurred at or adjacent to the Second Street Pike railroad highway grade crossing between September 1978 and December 1980. The accidents were sideswipe, angle, and rear-end types. None of the accidents involved trains. Of the seven accidents, only two injuries resulted. (See appendix F.)

A review of the Federal Railroad Administration's (FRA) records found only one reported accident at the crossing. The accident, which occurred on July 3, 1976, at 5:10 p.m., involved a two-locomotive passenger train that struck an "auto." The train was headed east, the "auto" north, and the flashers were reported to be working. In this accident, no one was injured and property damage was reported to be $500. (See appendix F.)

FRA accident data for January 1979 through October 1981 were examined for all accidents reported to have the "signaled crossing warning not working." Investigators eliminated accidents which involved audible warnings and those with highway traffic signals that were not interconnected to give a crossing warning with no other active warning devices were eliminated. Of the remaining 201 accidents (74 per year), 125 involved flashers, 67 involved gates, 4 involved wigwags, and 5 involved traffic signals.

The FRA data were tabulated and examined by month, temperature, weather, type of device, interconnection to traffic signals, motorist actions, and number of locomotives or cars in the train to determine if there were patterns in signal failures. The only outstanding pattern indicated that the accidents involved one car or one locomotive. Of the 201 accidents, 98 (48.8 percent) involved only one unit (car or locomotive) trains. Single locomotive units were involved in 22 accidents, of which 20 were coded as light locomotives: one accident occurred during a yard operation.

An FRA study 6/ conducted in 1977 examined 137 reported highway crossing signal failures during 1975 and 1976. The study stated that "In 1975, there were actually 25 signal failures; 12 are attributed to equipment failures, 9 are alledged to be human errors, and 4 were caused by vandalism. Ninety-five of the accidents were miscoded; 44 were actually working; 27 were actually not protected by active signals though active signals were reported; and 24 involved insulated equipment that was not designed to activate the signals. 7/ There were 17 reports that could not be classified."

In 1976, there were 124 highway crossing signal failures reported to the FRA. In these reports, 25 were actual signal failures; 12 were attributed to equipment failures, 10 were alleged to be human error, and 3 were caused by vandalism. Seventy-eight of the accidents were miscoded; 29 were actually working, 16 were actually passively protected though active signals were indicated, and 33 involved insulated equipment being operated over the crossing. There were 22 accidents that could not be classified.

Land Development.--Several businesses are located near the accident site along Second Street Pike. Immediately adjacent to the railroad highway grade crossing was a parking lot for the railroad station, furniture stores, parking lots, a donut shop (with a propane tank behind it), a gas station, and a large parking lot for a lumber yard.

A fuel oil storage area, operated by a distributor of Nos. 1 and 2 fuel oil 8/ is located on Knowles Avenue near Street Road. The distributor operates 12 vehicles, 2 tractor-trailers (7,500 gallon capacity), and 10 local delivery trucks (3,000- and 4,000-gallon capacity). In addition, five other oil companies regularly make deliveries from the distributor's terminal on Knowles Avenue. The manager of the storage area stated that the drivers for the company avoid the congestion at the Second Street Pike railroad crossing by using Street Road overpass. (See figure 9.) However, large trucks with semitrailer tanks cannot use this route unless a concrete island is modified so that the trucks can negotiate an acute turn. Therefore, large trucks must use Second Street Pike and cross the railroad track.

ANALYSIS

The Accident

The air brake tests performed by the operator and the conductor at Newtown and Fox Chase, the train's stop at Southampton Station, and the witnesses' statements that the train was slowly approaching the Second Street Pike Crossing indicate that the brakes on RDC No. 9164 were functioning as intended.

6/ "Non-Operation of Railroad-Highway Train Activated Automatic Grade Crossing Warning Devices," Michael G. Crawford, August 1977 for the Federal Railroad Administration.

7/ The 24 involving insulated equipment were logged in accordance with the reporting instructions in effect in 1975 and 1976 (i.e., FRA Guide for Preparing Accident/Incident Reports 1975, pg. 61) which state that a signal should be reported as operating "only if the railroad equipment consist activated a warning mechanism. . ." This instruction was amended somewhat in the 1977 version of the FRA Guide. The new instruction calls for submission of an "operating" report if the signal is activated, a nonoperating" report if the mechanism" fails to operate as intended, and a "N/A" if the equipment is insulated. Unfortunately, no provision for the "N/A" has been made in the software which accepts only a "1" (YES), "2" (NO), or blank.

8/ Fuel oils used for domestic heating and as a commerical fuel (diesel oil) for automobiles and trucks.

Figure 9.—Alternate truck route.

The conductor's statement that the whistle was sounding for the crossing and the train was slowing, indicates the operator was aware of his approach to the crossing and the Southampton Station stop. Based on the train's limited distance of travel after the collision, the operator was probably aware of the impending collision in sufficient time to apply the emergency brakes before impact. However, accident damage to the control stand precluded determining the throttle position and brake valve position at the time of the accident.

Tne conductor indicated that the train was traveling slowly at the crossing in preparation for stopping at the station about 200 feet beyond the crossing. If the operator saw the automatic grade crossing signals operating originally and the automobile stopped south of the crossing, he probably believed it was safe to continue with the assurance that other traffic would not enter the track. Therefore, he most likely did not notice that the crossing signals had stopped flashing.

Highway Vehicles.--A pedestrian north of the railroad track saw the automatic grade crossing signals momentarily operate. A driver in a vehicle south of the railroad saw the highway traffic lights turn red momentarily for Second Street Pike, Knowles Avenue, and the shopping center driveway, but then turn green for Second Street Pike. When the automatic grade protection was operating and the highway signal momentarily turned red, the attention of the truckdriver was most likely diverted, as he stated, by the car on his right which was preparing to enter Second Street Pike from Belmont Avenue. When he again focused his attention ahead, the highway traffic light for Second Street Pike was apparently green and the automatic grade crossing signals were not operating. This was confirmed by other witnesses' statements. Because his view of the eastbound train at the time was blocked by the building along the west side of Second Street Pike until he was about 35 feet from the crossing, because the crossing signals were no longer flashing, and because of the complexity of the Knowles Avenue Intersection, the truckdriver was unable to see or hear the train until he was near the crossing.

FHWA regulations require trucks carrying hazardous materials to stop, listen, and look in both directions before crossing railroad tracks. However, Pennsylvania regulations and the UVC make an exception where the grade crossing is protected by crossing gates, an alternately flashing light, or an official traffic control device displaying a green indication. The UVC and Pennsylvania and FHWA regulations also do not require a truck to stop when there is a functioning highway signal transmitting a green indication at the crossing. Therefore, the driver of the gasoline truck was not legally constrained from proceeding through the crossing without stopping, listening, and looking.

Before this accident the Safety Board had recommended the approach that hazardous material trucks should not stop at crossings with active devices. This approach was adopted to encourage uniformity and to avoid other types of accidents, such as trucks stalling or stopping on tracks, insufficient clearance intervals, and rearend accidents caused by following vehicles. In September 1981, the Safety Board issued recommendation H-81-76 (see appendix D) to FHWA to encourage this uniformity. FHWA responded in May 1982 that they were considering an Advance Notice of Proposed Rulemaking (ANPRM) on the issue and would collect and analyze additional acident data operational characteristics, and cost data. The ANPRM is undergoing final preparation before being issued.

At the accident vicinity, an alternative hazardous material route could be considered. A southbound route would use the overpass on Street Road, if going eastbound, to turn onto Knowles Avenue (southwest bound) and then turn at Second Street

Pike (southbound). This route would avoid the railroad grade crossing. However, to use this route, adjustments to the acute angle intersection at Street Road and Knowles Avenue would be necessary. The Safety Board believes that if a specific route, such as the Street Road, had been available for trucks carrying bulk hazardous materials, this accident would not have occurred.

Discussion of Speed Visibility and Impact.--The maximum engagement of the rail diesel car and the cargo tank trailer can be estimated by the elliptical indentation in the right front panel of the rail diesel car, which corresponds to the elliptical shape of the trailer's tank shell. The approximate point of impact can be determined by the point of the derailed front truck of the rail diesel car. If these vehicles are both backed up at a similar velocity until disengagement, the initial point of contact can be estimated as shown in figure 10.

The driver of the truck stated that when he saw the train he started to swerve left, but saw the car in the northbound lane and continued straight. At initial impact, it appears that the truck was straddling the southbound lane line with the front right of the tractor about 11 feet and the rear right of the trailer about 6 feet west of the west curb. If the truck had been traveling in the southbound lane during his approach to the tracks, as reported by witnesses, he could have only been about 1.5 feet from the curb and still have remained in his lane. Thus, he would have had to move laterally about 9.5 feet. The longitudinal distance to move over 9.5 feet and the amount of time to move that distance were calculated to be about 55 feet longitudinally and 2 seconds in time at an estimated speed of 15 to 20 mph. Thus, the truckdriver would have had to begin turning his wheels 57.5 feet before the front of his tractor location at impact, or about 22 feet before the crossing while in the southbound curb lane. Therefore, the truckdriver most likely did not see the approaching train until he was about 22 feet from the crossing.

A representative of Mack Trucks, Inc., stated that the tractor engine was set at 1,800 rpm; assuming a 15 percent tolerance, the maximum rpm would be 1,890 for this vehicle. For an 11-2.5 tire, the maximum tire radius would be about 20.46-inches. The rear axle ratio was 3.87.

The maximum speed for each gear was calculated as follows:

Gear	Transmission Ratio	Maximum Speed (mph)
1	8.59	6.9
2	4.99	11.9
3	2.84	20.9
4	1.66	35.8
5	1.00	59.5

The driver stated that he thought he was in third gear; however, when the truck was later examined by a mechanic, the transmission was found to be in fourth gear. The driver also stated that he thought he was traveling approximately 20 to 25 mph. The southbound driver 75 feet behind the truck estimated the truck's speed as very slow, about 15 mph. His statement and the truckdriver's statement, when combined with the gear range, would tend to indicate that the truck was traveling at a speed of 16 to 23 mph or in the third gear, and that the driver may have shifted gears to increase speed just before impact and did not recall this action.

9/ Special Study: "Railroad Highway Grade Crossing Accidents Involving Trucks Transporting Bulk Hazardous Materials" (NTSB-HZM-81-2).

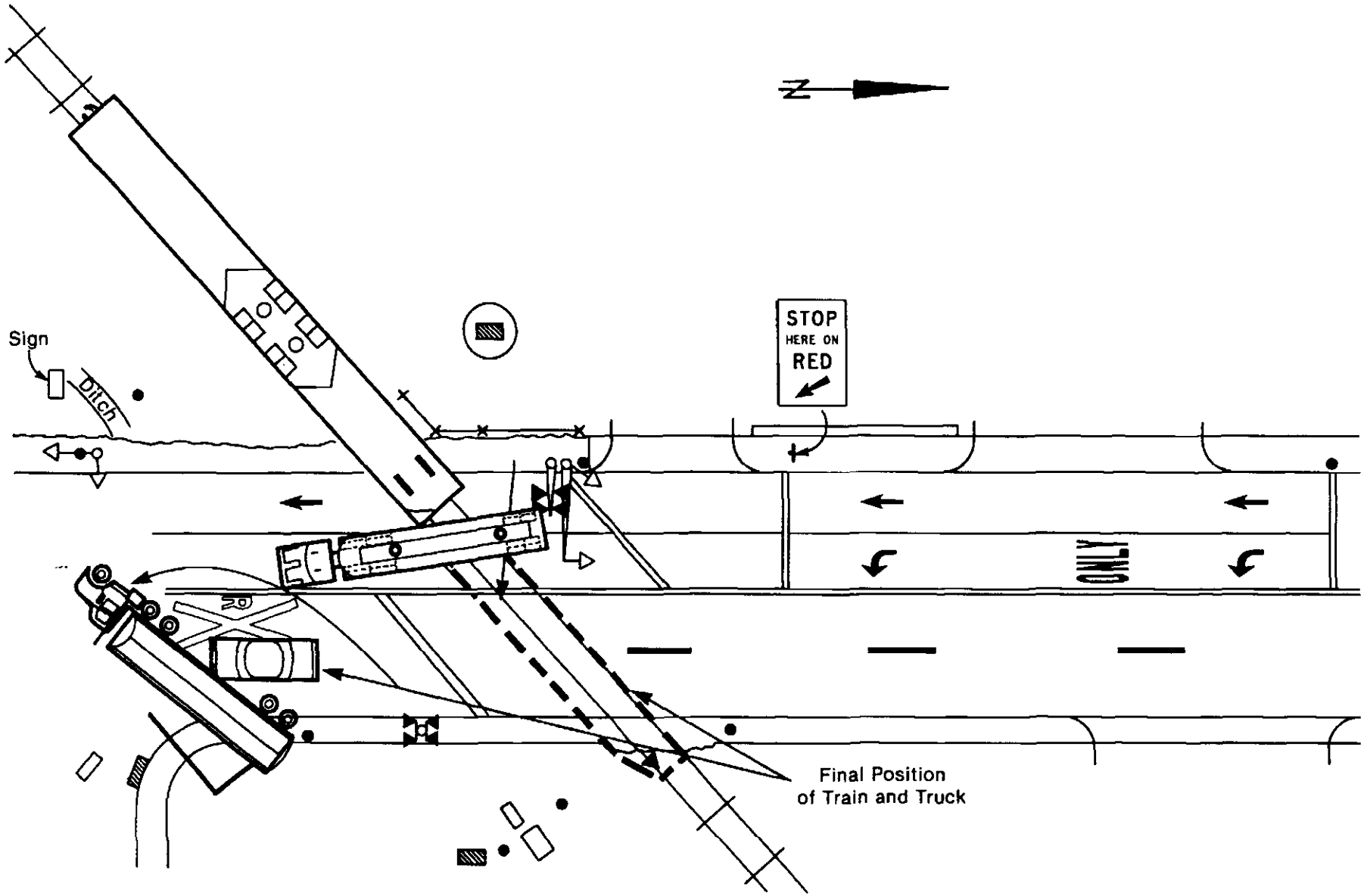


Figure 10.—Sketch of approximate initial impact.

The train approached the crossing at an angle of 131° 49' in the northwest quadrant. After impact, the train's front truck derailed and came to rest about 2 feet 4 inches from the rail. Thus, the lateral center of gravity was about 1 foot 2 inches from the track. The train moved about 14 feet after impact and then derailed, causing the 43-foot long gouge marks in the crossing timbers before coming to a stop.

Based on calculation, the speed of the train was estimated to be 16 to 27 mph with an expected speed of about 20 mph. This speed is higher than that estimated by the conductor, but speed is difficult to estimate while decelerating. It is also an appropriate speed for a train decelerating to stop at the station about 200 feet east of the crossing.

Visibility

The actual bearing of Second Street Pike is N 26° 41' E. Thus, the truck was heading 26°41' toward the southwest. It was calculated that, at the time of the accident, the altitude of the sun would have been just about 19°, and the azimuth would have been about 147°. The sun would have been 59.7° to the left of the truck's course as it approached the crossing. Thus, the amount of sun across the windshield would not have been significant to impair the visibility of the train and the crossing protection signals. Since there would have been two nearside traffic signals, a nearside railroad signal, a farside railroad signal, and three farside traffic signals displaying red to southbound motorists, if the signals were activated properly, it is not likely that the sun would have impaired visibility of all the signals.

The truckdriver stated that the traffic signal was green when he first saw the light near Belmont Avenue and that the railroad signals were not working. Belmont Avenue is about 370 feet north of the nearside signals. If the truck had been traveling at a constant speed of 19 mph, the truck would have traveled the 370 feet in about 13.24 seconds. The minimum green time for Second Street Pike without a railroad signal pulse is 30 seconds. The signals turn yellow instantly when a pulse is obtained that indicates the approach of a train, and 3 seconds later, the signal is red. The train at impact was traveling at an estimated 22 mph. If the train had begun to slow from its maximum speed of 40 mph at the rate of 1.6 feet per second per second and 750 feet to impact, the highway and railroad signals should have been red for about 37 seconds. Even at a constant speed of 40 mph after crossing the insulated joints 1,990 feet west of the crossing, the signals should have been red for 33.6 seconds. The truckdriver would not have perceived a green light at Belmont Avenue if the train had properly activated the signals. The driver who was northbound just before the collision stated, "the light was green and the railroad lights were not flashing." Also, the driver who was driving the 1978 Oldsmobile stated that, "the traffic light was green and the railroad lights were off." However, since some witnesses indicated the crossing signals did initially begin to flash, this most likely occurred when the train first crossed the insulated joints, or 37 seconds before the collision. At this time, the truck and automobile would have been at least 1,367 feet from the crossing if traveling at 25 mph and would most likely have not seen the signals momentarily flash, particularly if this occurred when the traffic signals on Second Street Pike were already displaying red.

If the signals had stopped functioning after initially being activated, the only other possible way this accident could have been prevented would have been if the train operator and the truckdriver had detected each other, either visually or audibly, and taken evasive action. However, visibility of the vehicles to each other was limited by a building. Based on time-speed diagrams, using the speed range calculated and assuming constant speed for the truck and constant deceleration for the train approaching the

station, the Safety Board calculated that the vehicles could have seen each other for approximately 5.3 seconds. Based on further calculations, the truck's brakes would have had to have been fully actuated 2.4 to 2.5 seconds before impact, and the train's brakes would have had to have been fully actuated 3.1 to 4.5 seconds before impact to have avoided a collision.

The American Association of State Highway and Transportation Officials design manual 10/ states that for design work "it is assumed that the perception time value is 1.5 seconds and that the total of perception and brake reaction times 2.5 seconds." Using either of these values, it is unlikely the train could have stopped in time to have avoided the collision. The truck probably could have stopped only if the vehicles collided at the minimum impact speeds calculated, and if the truckdriver had been looking in the direction of and reacted immediately to the approaching train. The truckdriver stated that he heard the train's whistle when he was on the crossing. This statement would tend to indicate that the driver did not perceive the approaching train until 2 seconds before impact. This would be consistent with his lane change effort to the left, which would require about 2 seconds. Thus, the driver perceived the approaching train too late to stop, but with enough time to turn slightly. The driver's lack of perception of the train may have been due to the complexity of the approaching intersection, its numerous traffic signals and the fact that the signals were displaying a green aspect as he approached the crossing.

The Rail Diesel Car

Single rail diesel cars have a history of failure to shunt track circuits because of their light weight. SEPTA and its predecessor, Conrail, were aware of the problem and issued Timetable General Instructions which require single rail diesel cars to approach highway grade crossings prepared to stop unless the automatic grade crossing protection is known to be working. Also, railroads have taken other measures to improve the ability of single rail diesel cars to shunt track circuits. Because the Budd rail diesel cars operated by SEPTA are equipped with disc brakes, the cars also are equipped with wheel scrubbers designed to free the wheel tread of dirt and provide a better electrical contact with the rail. However, due to the cars' light weight, train No. 114 apparently did not hold a constant shunt, most likely due to the nonuse of the track during the day before the accident and the possibility of a film of dirt and rust building upon the rails from frost and dew.

The effect of the headlights and oscillating light were mitigated by the clear weather conditions at the time of the accident. The high visibility panel's effect was of little use with the truck approaching the crossing southbound because of the limited visibility to the west. The Safety Board was unable to determine why the truckdriver did not hear the train's whistle before the truck entered the crossing since other witnesses heard the whistle being blown as the train approached the crossing. Since the truck cab was destroyed in the accident, the Safety Board believes that the driver did not hear the train's whistle because the windows of the cab were open only three-fourths inch, because of noises within the cab's interior, or because the driver may have been shifting the truck's gears.

10/ "A Policy on Geometric Design of Rural Highway," Association of State Highway Officials, 1965.

The ARCO Truck

The ARCO tractor semitrailer was operated and maintained as required by Federal regulations. There were no apparent mechanical defects that would have contributed to the cause of the accident. On March 31, 1982, the Safety Board recommended that ARCO:

> Develop and implement a company program to reduce the likelihood of railroad/highway grade crossing accidents involving trucks carrying bulk hazardous materials. (H-82-5)

ARCO replied that it has a comprehensive tank truck driver Safety Program in operation which functions effectively on a day-to-day basis and that drivers attend formal safety meetings each quarter and obtain bi-annual physical examinations. ARCO further stated that it is a member of the National Safety Council (NSC) and actively supports the council's programs.

The intent of the Safety Board's recommendation was to develop support for an emerging NSC expansion program for the ongoing "Operation Lifesaver" program. The expansion program is being developed with the assistance of many groups, including the former Southern Railway System (SRS). The program emphasizes the bulk hazardous material truck conflict with the rail vehicles while crossing at grade and includes training, better routing to avoid hazardous crossings, engineering to improve crossings, increased enforcement to obtain adherence to laws, and an effort to achieve uniformity in laws. The Safety Board encourages ARCO to take a lead in this program similar to that of Marathon Oil, Chevron, and the SRS. Marathon Oil and Chevron have reproduced the SRS's slide tape programs on this issue and are distributing them widely.

Crossing Signals

The automatic railroad grade crossing signal system functioned correctly during all tests. If the flasher lights failed to operate at the time of the accident, the problem was the loss of shunt by the rail diesel car. The highway traffic signal system could not be tested because the circuitry was destroyed in the fire. However, witness testimony indicated that when the railroad flashers operated, the highway signals turned red.

SEPTA is maintaining the signal equipment associated with the flasher protection in accordance with standards established by the FRA. However, the 1977 FRA study which examined reported highway crossing signal failures indicated that such failures occur even with equipment being maintained according to FRA standards. In addition, the study indicated 12 failures could not be classified and involved Conrail, which formerly owned the Fox Chase Line. These failures could very well have been caused by the loss of shunt. If the cables had been defective, the batteries had been low, the power had been turned off, or the ballast had leaked excessively, these types of problems would have caused the flasher lights to flash red because of its fail safe feature. However, if a problem had occurred because of a momentary loss of shunt by the RDC, the automatic grade crossing protection may have not been activated. This condition can be eliminated by using a relay designed to respond to the loss of energizing power before it moves to its deenergized position, or an electronic device can be used to slow the operation of appropriate relays in the crossing protection circuitry.

Survival Aspects

Gasoline escaped and ignited during the collision between the train and the truck. However, the Safety Board was unable to determine the specific source of ignition. Gasoline spread over the intersection, but did not flow under the rail car. Consequently only three of the seven reported injuries were burn injuries attributable to the hazardous material released. The spread of the released gasoline and fire was diverted away from the intersection by underground drains, reducing the threat to nearby dwellings and businesses.

The quick actions taken by the truckdriver and the northbound Oldsmobile driver during the first few moments after the accident, and the availability of viable escape routes after the vehicles came to rest, enabled both drivers to escape from the burning hazardous materials with minor injuries.

The train operator was badly injured and badly burned because his location in the forward compartment placed him at the most severely impacted part of the RDC. He was located in the car's right front corner, which struck the cargo tank. The impact breached the car structure, allowing escaping gasoline to enter the operator's compartment. The few seconds available to the operator between the time he detected the gasoline truck and the collision did not allow him adequate time to flee from the compartment before being severely injured. The front of the car was burning when firefighters arrived, with burning fuel still dripping from the front of the car, indicating that a substantial quantity of gasoline had entered the operator's compartment. Since the operator was found lying on the ground between the rails at the front of the car with burns over 80 percent of his body and no other traumatic injuries, he may have fallen, jumped, or climbed down from the front of the car before succumbing to injuries resulting from the burning gasoline.

The crash post located on the side of the front door of the RDC failed to provide any protection for the car's operator in this cornering collision. The collision peeled away the entire right corner of the car's operating compartment, exposing the operator to the full effect of the burning gasoline from the truck's ruptured fuel tank.

The structural damage at the front of the train also allowed the burning gasoline to enter the forward passenger compartment of the car. Fortunately, only the conductor and three passengers were in the car and they were near the rear. Had there been a full passenger load in the car, the inward opening doors at the ends of the passenger compartment might have trapped the passengers in the car with more disastrous results, as occurred in the similar single RDC/fuel truck collision on the Boston and Maine Corporation (B&M) Railroad in Everett, Massachusetts, on December 28, 1966. 11/ As a result of its investigation of that accident, the Safety Board recommended that the FRA:

> Initiate studies and action that will insure that, in an emergency, passengers can reliably escape from regular exits of passenger-carrying railroad cars. (R-68-13)

The Safety Board classified this recommendation as Closed—Acceptable Action" after the FRA responded that an occupancy protection and crash survivability study would be made.

11/ Railroad Accident Report released February 29, 1968, Boston and Main Corporation Single Diesel - Powered Passenger Car 563 Collision with Oxbow Transport Company Tank Truck at Second Street Railroad Highway Grade Crossing, Everett, Massachusetts, December 28, 1966.

The newer type of rail diesel cars, the SP2000 model, manufactured by the Budd Co., are now equipped with sliding doors at the sides and ends of the passenger compartments to preclude this problem. However, the older style cars should have the doors modified to facilitate exiting during an emergency.

Training

The operator of the rail diesel car had 9 years of experience operating rail cars on SEPTA. All but the last 3 months of his experience had been on the Broad Street subway line on which there are no highway grade crossings. Although the operator's training on the RDC and the physical characteristics of the Fox Chase Rapid Transit line may have been adequate, the operator was relatively inexperienced in operating RDC's over highway grade crossings. This could account for his failure to notice that the grade crossing protection had stopped functioning, and his failure to make the required stop before operating the train over the crossing under such a condition. The circumstances of this accident should be brought to the attention of all RDC operators during their training and rules examinations.

In 1981, the Safety Board published a special study concerning railroad/highway grade crossing accidents and transportation of hazardous materials involving trucks transporting bulk hazardous materials. The January 2, 1982, accident exemplifies the problems treated in the special study, which cited several similar accidents in which trains struck trucks hauling hazardous material over grade crossings. The Safety Board issued 14 recommendations as a result of the special study. Five recommendations to the FHWA concerned special routing of trucks carrying hazardous materials, improvements in existing grade crossing protection and licensing of drivers. These recommendations are open pending a satisfactory response. The Safety Board urges the FHWA to expeditiously address these outstanding unresolved recommendations concerning hazardous materials routed over railroad/highway grade crossings. As a matter of information, special study recommendations H-81-72 through -81, I-81-8 through -10, and R-81-96 are in appendix D.

CONCLUSIONS

Findings

1. The operator of the rail diesel car, although an experienced rail car operator, was relatively inexperienced in operating rail cars over grade crossings. He apparently failed to observe that the grade crossing protection had stopped functioning on Second Street Pike, or failed to observe it in time to stop the train before entering the crossing as required.

2. Although the equipment of the highway traffic signal system was destroyed in the fire, according to witnesses the highway traffic signals flashed red for an instant when the automatic railroad crossing signals were first flashing.

3. There were no mechanical defects in the truck which would have contributed to the accident.

4. Tests of the automatic grade crossing signal protection at Second Street Pike after the accident indicated that the signals would operate properly when activated.

5. The grade crossing flashers had stopped flashing because of a probable loss of shunting by the RDC car, and the highway traffic signal was green for Second Street Pike as the truck approached the crossing.

6. The single rail diesel car failed to shunt the track circuits because of its light weight, the nonuse of the track during the day before the accident and the possibility of a film of dirt and rust building upon the rails from frost and dew.

7. The train operator most likely did not notice that the crossing signals had stopped flashing because an automobile had stopped at the crossing awaiting the passage of the train.

8. The old style rail diesel car was equipped with inward opening doors which makes exiting of a large number of passengers very difficult during an emergency.

9. Had the potential alternate route via the Street Road overpass east of Second Street Pike been improved and designated at the time of the accident for hazardous material trucks, this accident could have been avoided.

10. The truckdriver was familiar with the route, having made deliveries in the area about twice a month during the past year.

11. The visibility of southbound highway traffic to eastbound trains was limited by buildings on the west side of Second Street Pike.

12. Because of the limited visibility, estimated speeds, and reaction time, the train and truck could not have stopped in time to avoid the accident.

13. Pennsylvania and Federal regulations did not require the truckdriver to stop before the crossing since a green indication was being displayed on the traffic light and the railroad flashing signals were not operating as the train approached the crossing.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was that the rail diesel car did not maintain a constant shunt of the track circuit, which resulted in the failure of the automatic crossing warning device to indicate to highway traffic the approach of the train.

RECOMMENDATIONS

In addition to safety recommendation H-82-5, the National Transportation Safety Board made the following recommendations on March 31, 1982:

—to the Commonwealth of Pennsylvania:

Adopt an "Operation Lifesaver" program as a foundation for a statewide effort to reduce accidents at railroad/highway grade crossings in Pennsylvania. (Class II, Priority Action) (H-82-4)

Status.—A representative from the Office of the Governor of Pennsylvania responded that the "activities proposed for an 'Operation Lifesaver' program would not address the majority of accidents occurring in Pennsylvania at our grade crossings." The response also stated that Operation Lifesaver would probably not have addressed the six 1980 reported fatal accidents which involved trains with contributing factors of drunk drivers, failure to respond to traffic control devices, proceeding after stopping, speed in excess of posted limits, and rough tracks. The Safety Board does not believe that the Commonwealth of Pennsylvania has a full grasp of the scope of an Operation Lifesaver program. Of the six reported fatal accidents listed, five would have been addressed by the program either through the education or enforcement sections. Therefore, the Safety Board is holding this recommendation in an "Open--Unacceptable Action" status.

—to the American Public Transit Association:

Assist the National Safety Council in its program to reduce the likelihood of railroad/highway grade crossing accidents involving trucks carrying bulk hazardous materials. (Class II, Priority Action) (R-82-19)

Encourage its members who operate rail systems to cooperate with local and State traffic authorities and operators of trucks carrying bulk hazardous materials in the designation of specific railroad/highway grade crossings to be used by the trucks, preferably crossings with a grade separation, but as a minimum crossings with automatic gates or other active warning devices. (Class II, Priority Action) (R-82-20)

Status.—The American Public Transit Association has not yet responded to the recommendations.

—to the Southeastern Pennsylvania Transportation Authority:

Develop and implement a program to reduce the likelihood of railroad/highway grade crossing accidents involving trucks carrying bulk hazardous materials and Southeastern Pennsylvania Transportation Authority commuter trains. (Class II, Priority Action) (R-82-21)

Status.—The Southeastern Pennsylvania Transportation Authority has not yet responded to the recommendation.

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

—to the Southeastern Pennsylvania Transportation Authority:

Modify the automatic grade crossing protection systems to eliminate the momentary loss of shunt in order to assure that all rail cars approaching grade crossings cause the crossing warning device to operate as intended. (Class II, Priority Action) (R-82-110)

Modify the inward opening passenger doors in the existing diesel rail cars to facilitate passenger evacuation in emergency situations. (Class II, Priority Action) (R-82-111)

Enhance your training and education program by bringing the circumstances of this accident to the attention of its employees in order to reduce the likelihood and severity of railroad/highway grade crossing accidents. (Class II, Priority Action) (R-82-112)

—to the Upper Southampton Township:

Work jointly with the Commonwealth of Pennsylvania's Department of Transportation to consider the establishment of hazardous material routes through Southampton with the necessary geometric changes that would eliminate the need for hazardous material trucks to cross the rail-highway grade crossing on Second Street Pike. (Class II, Priority Action) (H-82-57)

—to the Commonwealth of Pennsylvania, Department of Transportation:

Work jointly with the Upper Southhampton Township to consider the establishment of hazardous material routes through Southampton with the necessary geometric changes that would eliminate the need for hazardous material trucks to cross the rail-highway grade crossing on Second Street Pike. (Class II, Priority Action) (H-82-58)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES E. BURNETT, JR.
Chairman

/s/ PATRICIA A. GOLDMAN
Member

/s/ FRANCIS A McADAMS
Member

/s/ DONALD D. ENGEN
Member

G. H. PATRICK BURSLEY, Member, did not participate.

October 19, 1982

APPENDIXES

APPENDIX A

INVESTIGATION

The National Transportation Safety Board was notified of the accident about 2:45 p.m., e.s.t, on January 2, 1982. The Safety Board immediately dispatched two investigators from its New York field office to Southhampton, Pennsylvania. Subsequently, the investigators were joined by highway and hazardous materials specialists from the Safety Board's Bureau of Technology in Washington, D.C. The Southeastern Pennsylvania Transportation Authority, the Commonwealth of Pennsylvania, and the Bucks County Police Department cooperated in the investigation.

APPENDIX B

TITLE 49 – TRANSPORTATION PART 392 AND DEPARTMENT OF TRANSPORTATION COMMONWEALTH OF PENNSYLVANIA LIST OF VEHICLE CODE VIOLATIONS AND ASSOCIATE FINES

§ 392.10 Railroad grade crossings; stopping required.

(a) Except as provided in paragraph (b) of this section, the driver of a motor vehicle specified in paragraphs (a) (1) through (6) of this section shall not cross a railroad track or tracks at grade unless he first: Stops the vehicle within 50 feet of, and not closer than 15 feet to, the tracks; thereafter listens and looks in each direction along the tracks for an approaching train; and ascertains that no train is approaching. When it is safe to do so, the driver may drive the vehicle across the tracks in a gear that permits the vehicle to complete the crossing without a change of gears. The driver must not shift gears while crossing the tracks.

(1) Every bus transporting passengers,

(2) Every motor vehicle transporting any quantity of chlorine,

(3) Every motor vehicle which, in accordance with the regulations of the Department of Transportation, is required to be marked or placarded with one of the following markings:

(i) Explosives A
(ii) Explosives B
(iii) Poison Gas
(iv) Flammable solid W
(v) Radioactive
(vi) Flammable
(vii) Blasting Agent
(viii) Nonflammable Gas
(ix) Chlorine
(x) Poison
(xi) Oxygen
(xii) Flammable Gas
(xiii) Combustible
(xiv) Flammable Solid
(xv) Oxidizer
(xvi) Organic Peroxide
(xvii) Corrosive
(xviii) Dangerous

(4) Every cargo tank motor vehicle, whether loaded or empty, used for the transportation of any hazardous material as defined in the Hazardous Materials Regulations of the Department of Transportation, Parts 170-189 of this title.

(5) Every cargo tank motor vehicle transporting a commodity which at the time of loading has a temperature above its flash point as determined by § 173.115 of this title.

(6) Every cargo tank motor vehicle, whether loaded or empty, transporting any commodity under special permit in accordance with the provisions of § 170.13 of this title.

(b) A stop need not be made at:

(1) A streetcar crossing, or railroad tracks used exclusively for industrial switching purposes, within a business district as defined in § 390.12 of this chapter,

(2) A railroad grade crossing when a police officer or crossing flagman directs traffic to proceed,

(3) A railroad grade crossing controlled by a functioning highway traffic signal transmitting a green indication which, under local law, permits the vehicle to proceed across the railroad tracks without slowing or stopping.

(4) An abandoned railroad grade crossing which is marked with a sign indicating that the rail line is abandoned,

(5) An industrial or spur line railroad grade crossing marked with a sign reading "Exempt." Such "Exempt" signs shall be erected only by or with the consent of the appropriate State or local authority.

(Sec. 12, 80 Stat. 931; 49 U.S.C. 1651 note)

[33 FR 19732, Dec. 25, 1968, as amended at 35 FR 7801, May 21, 1970; 38 FR 1589, Jan. 16, 1973; 40 FR 44555, Sept. 29, 1975; 45 FR 46424, July 10, 1980]

§ 391.15 Disqualification of drivers.

(a) *General.* A driver who is disqualified shall not drive a commercial motor vehicle. A motor carrier shall not require or permit a driver who is disqualified to drive a commercial motor vehicle.

(b) *Disqualification for loss of driving privileges.* A driver is disqualified for the duration of his loss of his privilege to operate a commercial motor vehicle on public highways, either temporarily or permanently, by reason of the revocation, suspension, withdrawal, or denial of an operator's license, permit, or privilege, until that operator's license, permit, or privilege is restored by the authority that revoked, suspended, withdrew, or denied it.

(c) *Disqualification for criminal misconduct*—(1) *General rule.* A driver who is convicted of, or forfeits bond or collateral upon a charge of, a disqualifying offense specified in paragraph (c) (2) of this section is disqualified for the period of time specified in paragraph (c) (3) of this section if—

(i) The offense was committed after December 31, 1970; and

(ii) The offense was committed while the driver was driving a motor vehicle in the employ of a motor carrier or in furtherance of a commercial enterprise in interstate, intrastate, or foreign commerce.

(2) *Disqualifying offenses.* The following offenses are disqualifying offenses:

(i) Operating a motor vehicle while under the influence of alcohol, an amphetamine, a narcotic drug, a formulation of an amphetamine, or a derivative of a narcotic drug.

(ii) A crime involving the knowing transportation, knowing possession, or unlawful use of amphetamines, narcotic drugs, formulations of an amphetamine, or derivatives of narcotic drugs.

(iii) Leaving the scene of an accident which resulted in personal injury or death.

(iv) A felony involving the use of a motor vehicle.

(3) *Duration of disqualification for criminal misconduct*—(i) *First offenders.* A driver is disqualified for 1 year after the date of his conviction or forfeiture of bond or collateral if, during the 3 years preceding that date, he was not convicted of, and did not forfeit bond or collateral upon a charge of, an offense that would disqualify him under the rules of this section.

(ii) *Subsequent offenders.* A driver is disqualified for 3 years after the date of his conviction or forfeiture of bond or collateral if, during the 3 years preceding that date, he was convicted of, or forfeited bond or collateral upon a charge of, an offense that would disqualify him under the rules in this section.

[37 FR 24902, Nov. 23, 1972]

§ 391.25 Annual review of driving record.

Except as provided in Subpart G of this part, each motor carrier shall, at least once every 12 months, review the driving record of each driver it employs to determine whether that driver meets minimum requirements for safe driving or is disqualified to drive a motor vehicle pursuant to § 391.15. In reviewing a driving record, the motor carrier must consider any evidence that the driver has violated applicable provisions of the Federal Motor Carrier Safety Regulations and the Hazardous Materials Regulations. The motor carrier must also consider the driver's accident record and any evidence that the driver has violated laws governing the operation of motor vehicles, and must give great weight to violations, such as speeding, reckless driving, and operating while under the influence of alcohol or drugs, that indicate that the driver has exhibited a disregard for the safety of the public. A note, setting forth the date upon which the review was performed and the name of the person who reviewed the driving record, shall be included in the driver's qualification file.

[35 FR 6460, Apr. 22, 1970, as amended at 35 FR 17420, Nov. 13, 1970]

§3342. Vehicles required to stop at railroad crossings.

(a) General rule.--Except as provided in subsection (b), the driver of any vehicle described in regulations issued pursuant to subsection (c), before crossing at grade any track or tracks of a railroad, shall stop the vehicle within 50 feet but not less than 15 feet from the nearest rail of the railroad and while so stopped shall listen and look in both directions along the track for any approaching train, and for signals indicating the approach of a train, and shall not proceed until it can be done safely. After stopping and upon proceeding when it is safe to do so the driver of the vehicle shall cross only in such gear of the vehicle that there will be no necessity for manually changing gears while traversing the crossing and the driver shall not manually shift gears while crossing the track or tracks.

(b) Exceptions.--This section does not apply at any of the following:

(1) Any railroad grade crossing at which traffic is controlled by a police officer or flagman.

(2) Any railroad grade crossing at which traffic is regulated by a traffic control signal.

(3) Any railroad grade crossing protected by crossing gates or an alternately flashing light signal intended to give warning of the approach of a railroad train.

(4) Any railroad grade crossing at which an official traffic-control device gives notice that the stopping requirement imposed by this section does not apply.

(c) Regulations defining vehicles subject to section.--The department shall adopt such regulations as may be necessary describing the vehicles which must comply with the stopping requirements of this section. In formulating the regulations, the department shall give consideration to the hazardous nature of any substance carried by the vehicle as determined by the Hazardous Substances Transportation Board and to the number of passengers carried by the vehicle in determining whether the vehicle shall be required to stop. These regulations shall be developed in conjunction with the Pennsylvania Public Utility Commission and the Urban Mass Transportation Authority and shall correlate with and so far as possible conform to the current regulations of the United States Department of Transportation.

UNIFORM VEHICLE CODE

§11.703—Certain vehicles must stop at all railroad grade crossings

(a) Except as provided in subsection (b), the driver of any vehicle described in regulations issued pursuant to subsection (c), before crossing at grade any track or tracks of a railroad, shall stop such vehicle within 50 feet but not less than 15 feet from the nearest rail of such railroad and while so stopped shall listen and look in both directions along such track for any approaching train, and for signals indicating the approach of a train and shall not proceed until he can do so safely. After stopping as required herein and upon proceeding when it is safe to do so the driver of any said vehicle shall cross only in such gear of the vehicle that there will be no necessity for manually changing gears while traversing such crossing and the driver shall not manually shift gears while crossing the track or tracks.

(b) This section shall not apply at

1. Any railroad grade crossing at which traffic is controlled by a police officer or human flagman;

2. Any railroad grade crossing at which traffic is regulated by a traffic-control signal;

3. Any railroad grade crossing protected by crossing gates or an alternately flashing light signal intended to give warning of the approach of a railroad train;

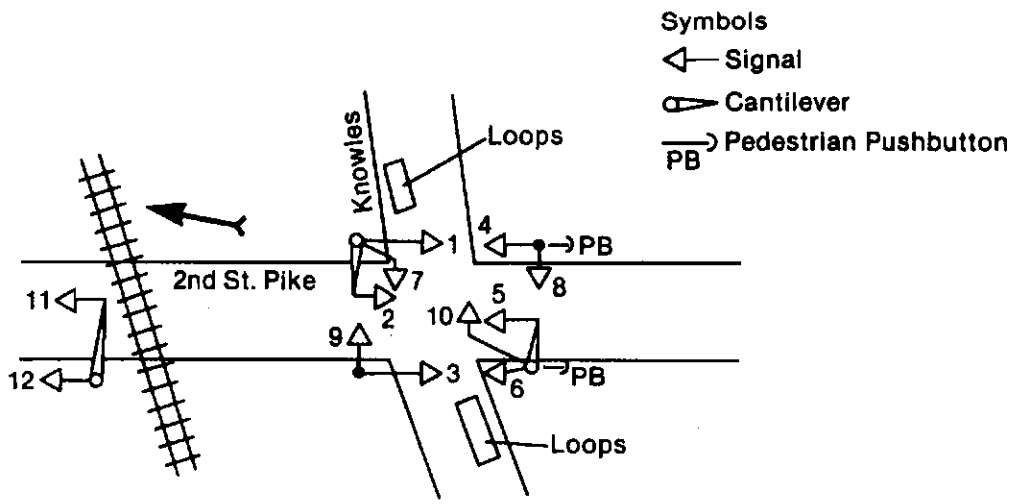
4. Any railroad grade crossing at which an official traffic control device gives notice that the stopping requirement imposed by this section does not apply.

(c) The (commissioner or other appropriate State official or agency) shall adopt such regulations as may be necessary describing the vehicles which must comply with the stopping requirements of this section. In formulating such regulations the (commissioner or other appropriate State official or agency) shall give consideration to the number of passengers carried by the vehicle and the hazardous nature of any substance carried by the vehicle in determining whether such vehicle shall be required to stop. Such regulations shall correlate with and so far as possible conform to the most recent regulation of the United States Department of Transportation.* (SECTION REVISED, 1971.)

APPENDIX C
SIGNAL PHASING

Signal Phasing—Second Street Pike and Knowles Avenue
G = Green Y = Yellow R = Red

Signals	Phase A	Phase B	RAILROAD PREEMPTION: When Green on 2nd St. Pike	RAILROAD PREEMPTION: When Green on Knowles Ave.	Flashing
1	G Y R R	R R R	G Y R R R	R R R R R	Y
2	G Y R R	R R R	G Y R R R	R R R R R	Y
3	G Y R R	R R R	G Y R R R	R R R R R	Y
4	G G Y R	R R R	G G G Y R	R R G Y R	Y
5	G G Y R	R R R	G G G Y R	R R G Y R	Y
6	G G Y R	R R R	G G G Y R	R R G Y R	Y
7	R R R R	G Y R	R R R R R	G Y R R R	R
8	R R R R	G Y R	R R R R R	G Y R R R	R
9-10	R R R R	G Y R	R R R R R	G Y R R R	R
11-12	G Y R R	R R R	G Y R R R	R R R R R	Y
Fixed	30 3 5 2	X 3 2	3 2 3 ↑	3 2 3 ↑	
Initial Interval		7	Train will terminate time		
Vehicle Interval		5			
Maximum		22			
Pedestrian Timer		18			



(Not to Scale)

Signals remain green for traffic on Second Street Pike and red for traffic on Knowles Avenue and the shopping center driveway until actuated by vehicular detectors located on Knowles Avenue and the driveway, or by pedestrain pushbuttons. When a train activates the railroad grade crossing flasher protection, all signals display red, except for a right turn arrow for vehicular traffic from Second Street Pike to Knowles Avenue south of the railroad track. If the train activates the railroad preemptive device and the signal is green for Second Street Pike, the following sequence will occur:

1. The Second Street Pike signals will turn yellow north of the tracks for southbound and northbound traffic.

2. Three seconds later, the Second Street Pike signals in sequence No. 1 will turn red.

3. Two seconds later, the green signals for southbound traffic south of Knowles Avenue will turn yellow.

4. Three seconds later, all signals will turn red.

If the train activates the railroad preemptive device and the signal is green on Knowles Avenue, the following sequence will occur:

1. The green Knowles Avenue signals will turn yellow.

2. Three seconds later, the yellow signals will turn red and the signals for southbound traffic south of Second Street Pike will turn green.

3. Two seconds later the Second Street Pike will turn yellow.

4. Three seconds later, all signals will turn red.

When no trains are in the area, the highway traffic signals provide a 30- to 33-second minimum green interval for Second Street Pike. When a vehicle crosses the detection loops on Knowles Avenue, the Second Street Pike signals turns yellow for 5 seconds and then turns red for 2 seconds. The signals then turns green for Knowles Avenue for a minimum of 12 seconds, plus 5 seconds per additional vehicle up to a maximum of 22 seconds. This is followed by a 3-second yellow and a 2-second "all red" interval. If a pedestrian activates the signal to cross Second Street Pike, the signal for Knowles Avenue will remain green for 18 seconds, and a 3-second yellow and 2-second "all red" interval will occur.

APPENDIX D

EXCERPTS FROM TIMETABLE SPECIAL INSTRUCTIONS OF SEPTA FOX CHASE RAPID TRANSIT LINE

* * *

5. PUBLIC CROSSINGS AT GRADE

Crossing	Mile Post	Protection	Instructions
XXXXXX	XXXX	XXXXXX	XXXXXX
Second St. Pike	1889	Flashers	1
XXXX	XXX	XXXX	

NOTE 1 - Trains and engines must approach crossing prepared to stop unless it is known the automatic highway crossing protection is operating. If the automatic highway protection is not operating trains must stop and ascertain that crossing is clear before proceeding.

APPENDIX E

SPECIAL STUDY RECOMMENDATIONS H-81-72 THROUGH -81; I-81-8 THROUGH -10; AND R-81-96

As a result of Special Study NTSB-HZM-81-2, the National Transportation Safety Board made these recommendations:

—to the Federal Highway Administration:

Encourage States to identify crossings with passive warning devices used by trucks transporting bulk hazardous materials and to designate specific routes, which have grade separations or crossings with active warning devices, for trucks carrying bulk hazardous materials to use near hazardous materials terminals and depots. (Class II, Priority Action) (H-81-72)

Establish a method which, through a cooperative effort of hazardous materials carriers and the railroads, will identify to the States crossings that are frequently used by bulk hazardous materials trucks and that need improved warning devices. (Class II, Priority Action) (H-81-73)

Status.—In its May 4, 1982, response, the FHWA said that it was "looking into the possibility of the formation of a multidisciplinary advisory group in each State to deal with the problem of accident involving hazardous materials carriers at railroad-highway crossings. The members of the advisory group would be made up of representatives of State and Federal Government, and the trucking and railroad industries." As a result of its response, recommendations H-81-72 and -73 are being held in an "Open--Acceptable Action" status.

Issue an "On Guard" Bulletin to shippers and carriers of bulk hazardous materials alerting drivers of trucks carrying bulk hazardous materials to the dangers of crossings. The bulletin should encourage drivers to use routes with grade separations or crossings with active warning devices and to report to their supervisors the locations of crossings with passive warning devices that must be used. (Class II, Priority Action) (H-81-74)

Status.—The FHWA published an On-Guard Bulletin in March 1982. Therefore, safety recommendation H-81-74 has been classified as "Closed--Acceptable Action," status.

Modify the informational document "Criteria to Designate Routes for Transporting Hazardous Materials" to specifically address the hazards of crossings. (Class III, Longer-Term Action) (H-81-75)

Status.—The FHWA is currently performing a study to investigate and relate the role of rail-highway crossings in hazardous materials routing. Recommendation H-81-75 is being held in an "Open—Acceptable Alternate Action" status.

Study the feasibility of requiring drivers to have an additional national or State license or endorsement to drive trucks used to transport bulk hazardous materials. The study should establish criteria for prior driving record and training in handling hazardous materials and in emergency procedures. (Class III, Longer-Term Action) (H-81-76)

Status.—The FHWA agrees that a study should be performed and will consider it in future funding. Recommendation H-81-76 is being held in an "Open--Acceptable Action" status.

Amend 49 CFR 392.10 to require trucks carrying bulk hazardous materials to stop at crossings with active warning devices only when the devices are activated to warn drivers of an approaching train, so that it will be consistent with the Uniform Vehicle Code. (Class II, Priority Action) (H-81-77)

Status.—The FHWA is considering publication of an Advance Notice of Proposed Rulemaking to obtain more definitive information from additional sources, rather than amending 49 CFR 392.10 at the present time. Recommendation H-81-77 is being held in an "Open--Acceptable Action" status.

—to the Secretary of Transportation:

Include the National Highway Traffic Safety Administration as a member of the task force for the Hazardous Materials Information System which will determine hazardous materials data needs for accident reports. (Class II, Priority Action) (I-81-8)

Status.—In its response dated July 26, 1982, the Office of the Secretary of Transportation said that it favored an informal coordinating committee for the purpose of sharing existing data and determining future needs. Recommendation I-81-8 is being classified as "Closed--Acceptable Action."

Consider the development of uniform short supplemental accident data forms to supplement existing Federal Highway Administration, Federal Railroad Administration, and National Highway Traffic Safety Administration accident report forms. (Class III, Longer-Term Action) (I-81-9)

Status.—Based on its description of the consideration given to the development of a supplemental short form for accident data related to hazardous materials, recommendation I-81-9 is being classified as "Closed--Acceptable Action."

Put into effect methodology to cross-reference accidents compiled by Department of Transportation administrations to periodically assess the validity of the data and the completeness of the data files, and to prepare detailed case analyses. (Class III, Longer-Term Action) (I-81-10)

Status.—The DOT has established a pilot program to cross-reference hazardous materials accident data between the Research and Specials Programs Administration and the Federal Railroad Administration. Therefore, recommendation I-81-10 has been classified as "Open--Acceptable Action."

—to the Research and Special Programs Administration:

Include in the hazardous materials enforcement courses offered through the Transportation Safety Institute instructions concerning driver responsibilities at crossings when transporting bulk hazardous materials. (Class III, Longer-Term Action) (H-81-78)

Status.—The RSPA has incorporated "the operative section of the regulations in hazardous materials training courses where it did not exist and placed increased emphasis on this section in courses where it already was included." Recommendation H-81-78 has been classified as "Closed--Acceptable Action."

—to the National Safety Council:

Expand the existing Operation Lifesaver program to include a specific program which addresses the problems with trucks carrying bulk hazardous materials, especially petroleum products, over crossings. (Class II, Priority Action) (H-81-79)

Status.—The NSC has began efforts to expand its railroad/highway grade crossing safety program as recommended. Recommendation H-81-79 is being held in an "Open—Acceptable Action" status pending reports of progress in the NSC's attempts to enlist financial and professional expertise support.

—to the International Association of Chiefs of Police (IACP); American Trucking Associations, Inc. (ATA); National Tank Truck Carriers Association (NTTC); the American Petroleum Institute (API); Brotherhood of Locomotive Engineers (BLE); United Transportation Union (UTU); Association of American Railroads (AAR); and Governors of all States:

Assist the National Safety Council in its program to reduce accidents involving trucks carrying bulk hazardous materials across crossings. (Class II, Priority Action) (H-81-80)

Status.—The IACP has not responded to the recommendation.

On October 22, 1982, the ATA described its support of and participation in the NSC's activities. The Safety Board has classified recommendation H-81-80 "Closed—Acceptable Action" for the ATA.

On November 3, 1981, the NTTC committed its resources and staff to becoming actively involved in programs and projects that are aimed at reducing the impact of hazardous materials truck accidents at railroad crossings. The Safety Board has classified recommendation H-81-80 "Open--Acceptable Action" pending further response from the organization.

The API responded on October 23, 1981, that it had "sent the recommendation to its Highway Transportation Committee for consideration of any further action which might be taken to mitigate the problem." Pending further information on the outcome of the committee's consideration, recommendation H-81-80 is being classified as "Open—Acceptable Action."

The BLE responded on November 3, 1981, that it endorses recommendation H-81-80 and will cooperate with the National Safety Council in this program. The recommendation is being classified as "Open—Acceptable Action" pending the beginning of an active program.

The UTU has not responded to the recommendation.

The AAR acknowledge receipt of the recommendation.

None of the Governors have responded to the recommendation

—to the Association of American Railroads:

Encourage railroads to develop programs for train crewmembers to report: (1) truck carriers identified as transporters of bulk hazardous materials, (2) crossings with passive warning devices which are used frequently by bulk hazardous materials trucks, and (3) bulk hazardous materials trucks which are involved in near-collisions. (Class II, Priority Action) (R-81-96)

The AAR has not responded to the recommendation.

—to all States:

Review State laws and regulations regarding the transportation of bulk hazardous materials by trucks across crossings and modify them to conform with the Uniform Vehicle Code. (Class III, Longer-Term Action) (H-81-81)

None of the Governors have responded to the recommendation.

ACCIDENT/INCIDENT REPORT

TABLE 1

ACCIDENT SUMMARY 1978-1980

BUCKS COUNTY, UPPER SOUTHAMPTON TOWNSHIP, PA.

LR 362 (State Route 232) between Knowles Avenue. (Sta. 50) and Belmont Avenue. (Sta. 55)

CASE NO.	10 a.m.	DATE	LOCATION	TYPE	SEVERITY	TYPE(s) OF VEHICLES
8095696	8 a.m.	9/26/78	STA 54	Rear-end	PD	Truck**-Truck-Car
9115620	10 a.m.	10/6/79	STA 51	Angle	PD	Car-Car
9154420	10 a.m.	12/24/79	STA 54	Side-swipe (same dir.)	INJURY (1)	Car-Car
0025173	8 p.m.	3/27/80	STA 51	Angle	PD	Car-Truck
0075439	1 p.m.	8/5/80	STA 51	Rear-end	INJURY (1)	Truck-Car-Car
0020474	NOON	3/15/80	STA 54	Side-swipe (Same dir.)	PD	Car-Car
0130311	2 p.m.	12/29/80	STA 54	Angle	PD	Tractor Trailer-Car

*PD=Property Damage Only.

**Truck=Straight Truck.

APPENDIX F

RAIL-HIGHWAY GRADE CROSSING
ACCIDENT/INCIDENT REPORT

GRADE CROSSING ID: 589793N DATE OF INCIDENT: 07/03/76 TIME: 0510 PM

RAILROADS INVOLVED	INCIDENT NUMBER	ALPHABETIC CODE	
REPORTING RAILROAD:	0340308	CR	CONSOLIDATED RAIL CORP.
OTHER RAILROAD INVOLVED:	---	---	
RAILROAD RESPONSIBLE FOR TRACK MAINTENANCE:	---	---	

PART 1: LOCATION

NEAREST RAILROAD STATION: SOUTHAMPTON COUNTY: BUCKS STATE: PENNSYLVANIA
CITY: SOUTHAMPTON HIGHWAY: 2ND STREET PIKE

PART 2: INCIDENT SITUATION

HIGHWAY USER INVOLVED: AUTO EQUIPMENT INVOLVED: TRAIN(UNITS PULLING)
SPEED: 025 MPH VEHICLE DIRECTION: NORTH
POSITION OF CAR UNIT IN TRAIN: 001
POSITION: MOVING OVER CROSSING CIRCUMSTANCE: TRAIN STRUCK HIGHWAY USER
WAS HIGHWAY USER AND/OR RAIL EQUIPMENT INVOLVED IN THE IMPACT TRANSPORTING HAZARDOUS MATERIALS? NEITHER

PART 3: ENVIRONMENT

TEMPERATURE: 084 F VISIBILITY: DAY WEATHER: CLEAR

PART 4: TRAIN AND TRACK

TYPE OF TRAIN: PASSENGER TYPE OF TRACK: MAIN
TRACK NUMBER OR NAME: SINGLE MAIN FRA TRACK CLASSIFICATION: 3
NUMBER OF CARS: 000 NUMBER OF LOCOMOTIVE UNITS: 02
TRAIN SPEED: 006 MPH (ESTIMATED) TIME TABLE DIRECTION: EAST

PART 5: CROSSING WARNING

TYPE:						
GATES	NO	HWY. TRAFFIC SIGNALS	NO	WATCHMAN		NO
CANTILEVER FLS	NO	AUDIBLE	NO	FLAGGED BY CREW		NO
STANDARD FLS	YES	CROSSBUCKS	NO	OTHER		NO
WIG WAGS	NO	STOP SIGNS	NO	NONE		NO

WAS THE SIGNALED CROSSING WARNING WORKING? YES LOCATION OF WARNING: BOTH SIDES
WAS CROSSING WARNING INTERCONNECTED WITH HIGHWAY SIGNALS? YES WAS CROSSING ILLUMINATED BY STREET LIGHTS OR SPECIAL LIGHTS:

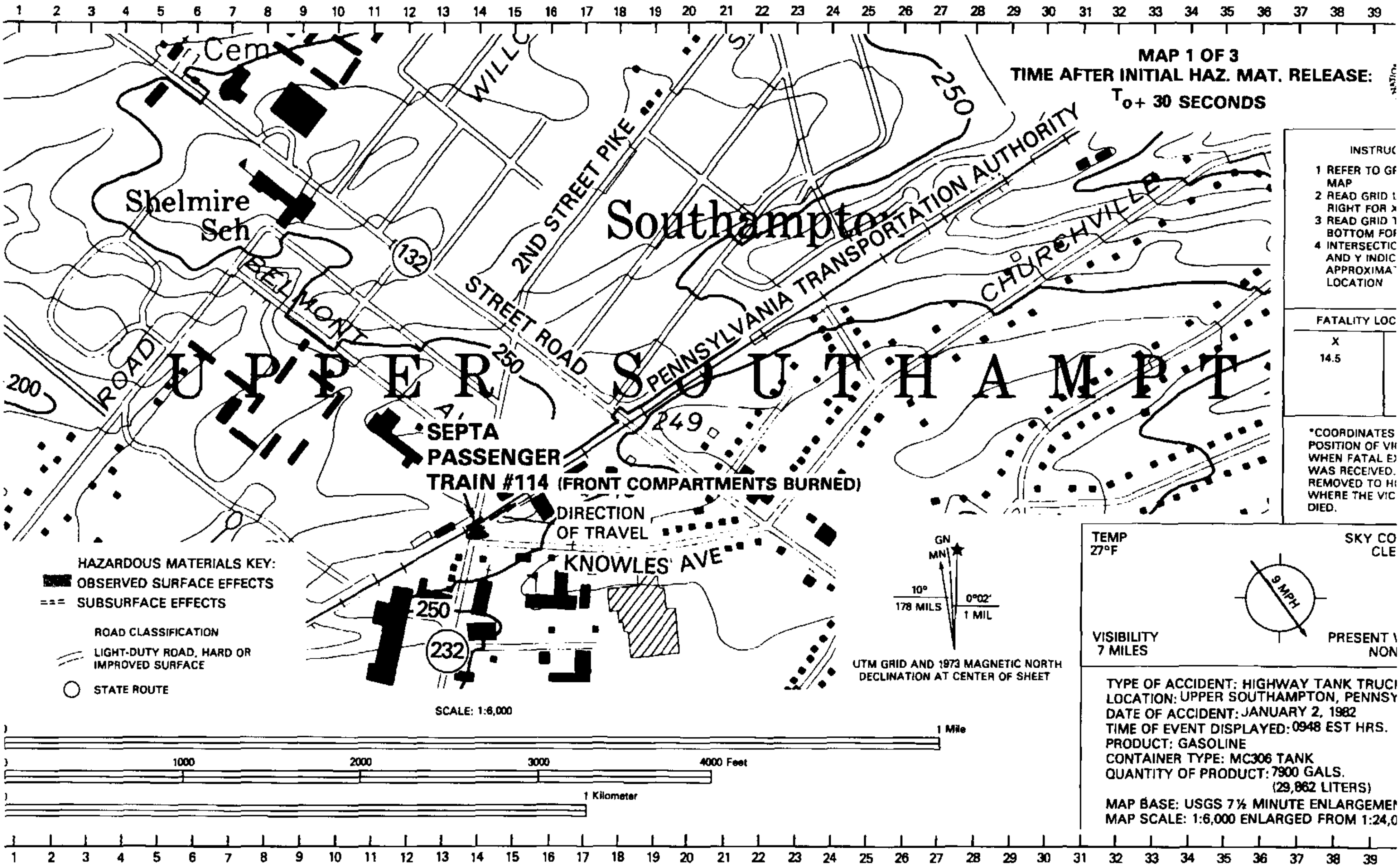
PART 6: MOTORIST ACTION

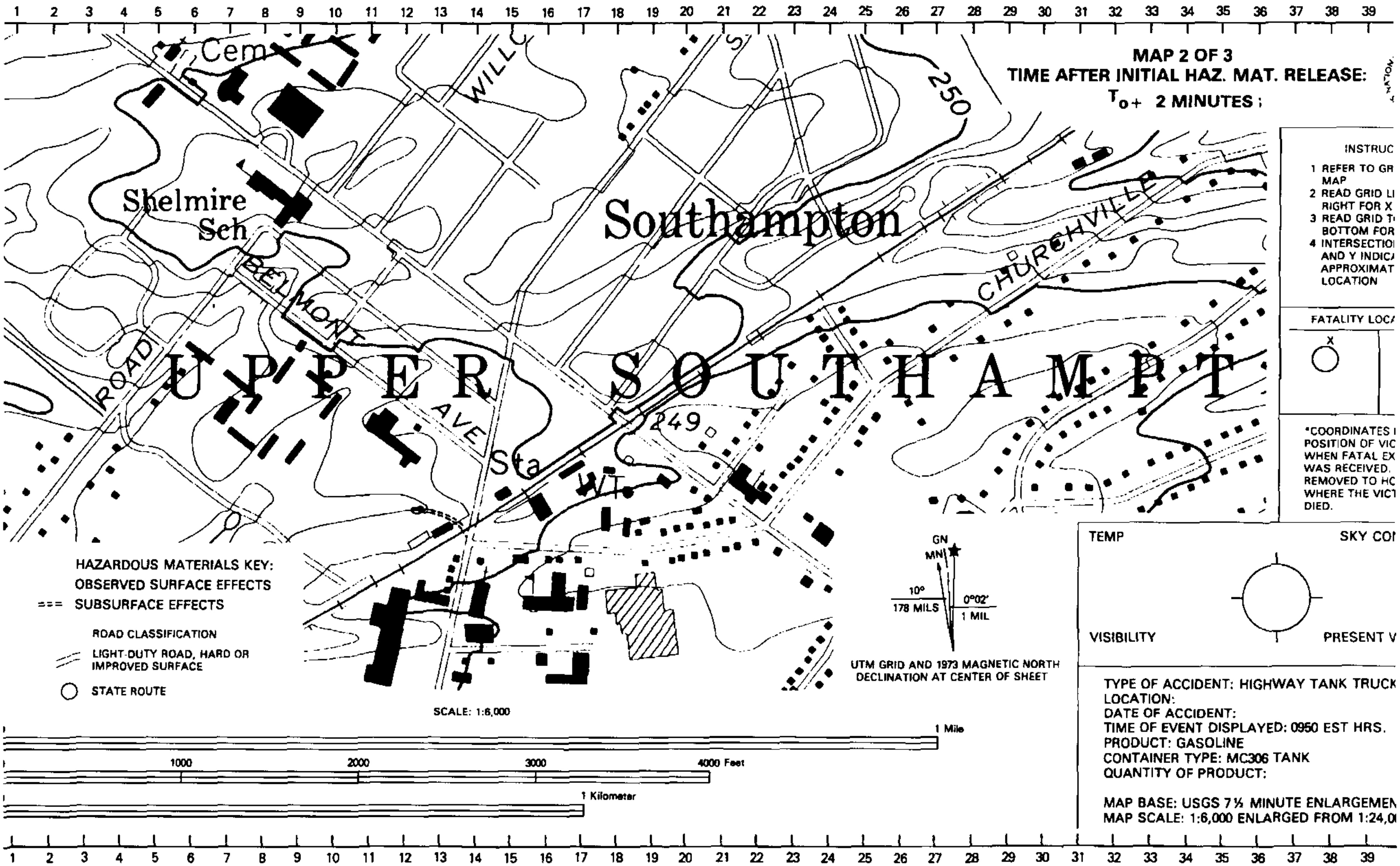
MOTORIST PASSED STANDING HIGHWAY VEHICLE: UNKNOWN MOTORIST DROVE BEHIND OR IN FRONT OF TRAIN AND STRUCK OR WAS STRUCK BY SECOND TRAIN: NO
MOTORIST DID NOT STOP
VIEW OF TRACK OBSCURED BY NOTHING

PART 7: HIGHWAY VEHICLE PROPERTY DAMAGE/CASUALTIES

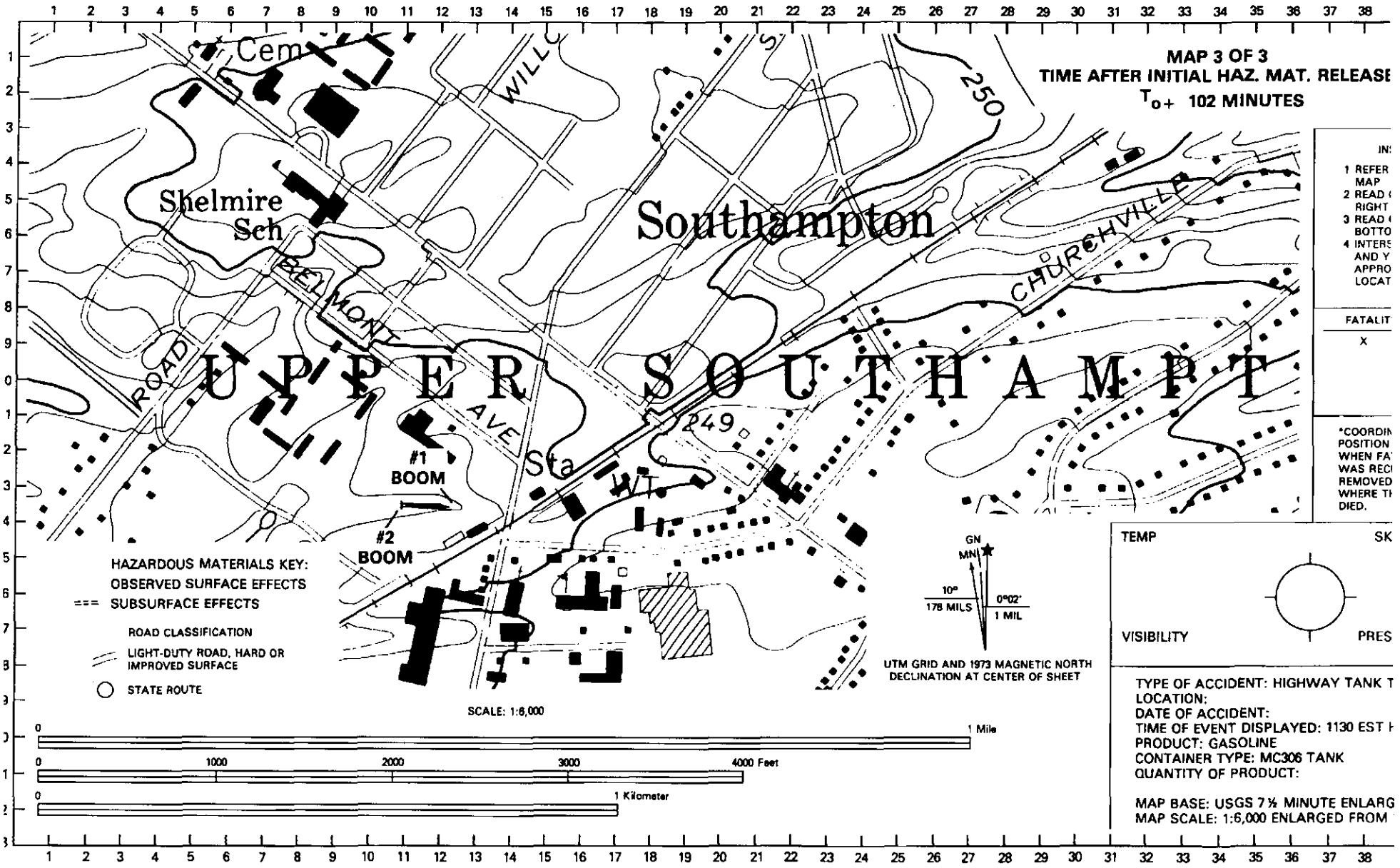
HIGHWAY VEHICLE PROPERTY DAMAGE: $500.00 DRIVER WAS UNINJURED
TOTAL NUMBER OF OCCUPANTS KILLED: 0000 WAS DRIVER IN THE VEHICLE ? YES
TOTAL NUMBER OF OCCUPANTS INJURED: 0000 TOTAL NUMBER OF OCCUPANTS INCLUDING DRIVER: 0000

ITEMNO. 00016707


MAP 1 OF 3
TIME AFTER INITIAL HAZ. MAT. RELEASE:
To+ 30 SECONDS
Cem
Shelmire Sch
Southampton
UPPER SOUTHAMPT
WILLO
2ND STREET PIKE
STREET ROAD
BELMONT
ROAD
PENNSYLVANIA TRANSPORTATION AUTHORITY
CHURCHVILLE
132
250
200
249
SEPTA PASSENGER TRAIN #114 (FRONT COMPARTMENTS BURNED)
DIRECTION OF TRAVEL
KNOWLES AVE
232
HAZARDOUS MATERIALS KEY:
OBSERVED SURFACE EFFECTS
SUBSURFACE EFFECTS
ROAD CLASSIFICATION
LIGHT-DUTY ROAD, HARD OR IMPROVED SURFACE
STATE ROUTE
SCALE: 1:6,000
1 Mile
1000
2000
3000
4000 Feet
1 Kilometer
GN
MN
10°
178 MILS
0°02'
1 MIL
UTM GRID AND 1973 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
INSTRUC
1 REFER TO GF MAP
2 READ GRID L RIGHT FOR X
3 READ GRID T BOTTOM FOR
4 INTERSECTIC AND Y INDIC APPROXIMAT LOCATION
FATALITY LOC
X
14.5
*COORDINATES POSITION OF VI WHEN FATAL E WAS RECEIVED. REMOVED TO H WHERE THE VIC DIED.
TEMP 27°F
SKY CO CLE
9 MPH
VISIBILITY 7 MILES
PRESENT NON
TYPE OF ACCIDENT: HIGHWAY TANK TRUC
LOCATION: UPPER SOUTHAMPTON, PENNSY
DATE OF ACCIDENT: JANUARY 2, 1982
TIME OF EVENT DISPLAYED: 0948 EST HRS.
PRODUCT: GASOLINE
CONTAINER TYPE: MC306 TANK
QUANTITY OF PRODUCT: 7900 GALS. (29,862 LITERS)
MAP BASE: USGS 7½ MINUTE ENLARGEME
MAP SCALE: 1:6,000 ENLARGED FROM 1:24,0



MAP 2 OF 3
TIME AFTER INITIAL HAZ. MAT. RELEASE:
To+ 2 MINUTES ;
Cem
WILLO
250
Shelmire
Sch
Southampton
BELMONT
CHURCHVILLE
ROAD
UPPER SOUTHAMPT
AVE
Sta
249
INSTRUC
1 REFER TO GR
MAP
2 READ GRID LI
RIGHT FOR X
3 READ GRID T
BOTTOM FOR
4 INTERSECTIO
AND Y INDIC
APPROXIMAT
LOCATION
FATALITY LOC
X
*COORDINATES I
POSITION OF VIC
WHEN FATAL EX
WAS RECEIVED.
REMOVED TO HO
WHERE THE VICT
DIED.
HAZARDOUS MATERIALS KEY:
OBSERVED SURFACE EFFECTS
SUBSURFACE EFFECTS
ROAD CLASSIFICATION
LIGHT-DUTY ROAD, HARD OR IMPROVED SURFACE
STATE ROUTE
GN
MN
10°
178 MILS
0°02'
1 MIL
UTM GRID AND 1973 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
SCALE: 1:6,000
1 Mile
1000
2000
3000
4000 Feet
1 Kilometer
TEMP
SKY CO
VISIBILITY
PRESENT V
TYPE OF ACCIDENT: HIGHWAY TANK TRUCK
LOCATION:
DATE OF ACCIDENT:
TIME OF EVENT DISPLAYED: 0950 EST HRS.
PRODUCT: GASOLINE
CONTAINER TYPE: MC306 TANK
QUANTITY OF PRODUCT:
MAP BASE: USGS 7½ MINUTE ENLARGEMEN
MAP SCALE: 1:6,000 ENLARGED FROM 1:24,0


MAP 3 OF 3
TIME AFTER INITIAL HAZ. MAT. RELEASE
T_{o+} 102 MINUTES
Shelmire Sch
Southampton
UPPER SOUTHAMPT
Cem
WILLO
250
CHURCHVILLE
ROAD
BELMONT
AVE
Sta
249
#1 BOOM
#2 BOOM
HAZARDOUS MATERIALS KEY:
OBSERVED SURFACE EFFECTS
=== SUBSURFACE EFFECTS
ROAD CLASSIFICATION
LIGHT-DUTY ROAD, HARD OR IMPROVED SURFACE
STATE ROUTE
GN
MN
10°
178 MILS
0°02'
1 MIL
UTM GRID AND 1973 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
SCALE: 1:6,000
0
1 Mile
0
1000
2000
3000
4000 Feet
0
1 Kilometer
1 REFER MAP
2 READ RIGHT
3 READ BOTTO
4 INTERS AND Y APPRO LOCAT
FATALIT
X
*COORDIN POSITION WHEN FA WAS REC REMOVED WHERE TI DIED.
TEMP
SK
VISIBILITY
PRES
TYPE OF ACCIDENT: HIGHWAY TANK T
LOCATION:
DATE OF ACCIDENT:
TIME OF EVENT DISPLAYED: 1130 EST H
PRODUCT: GASOLINE
CONTAINER TYPE: MC306 TANK
QUANTITY OF PRODUCT:
MAP BASE: USGS 7½ MINUTE ENLARG
MAP SCALE: 1:6,000 ENLARGED FROM