INTERSTATE COMMERCE COMMISSION

Ex Parte No. 173

ACCIDENT AT WOODBRIDGE, N. J.

Submitted February 12, 1951 Decided April 19, 1951.

Accident at Woodbridge, N. J., on February 6, 1951, caused by excessive speed on a curve of a temporary track.

Recommended that an automatic train-control system be installed.

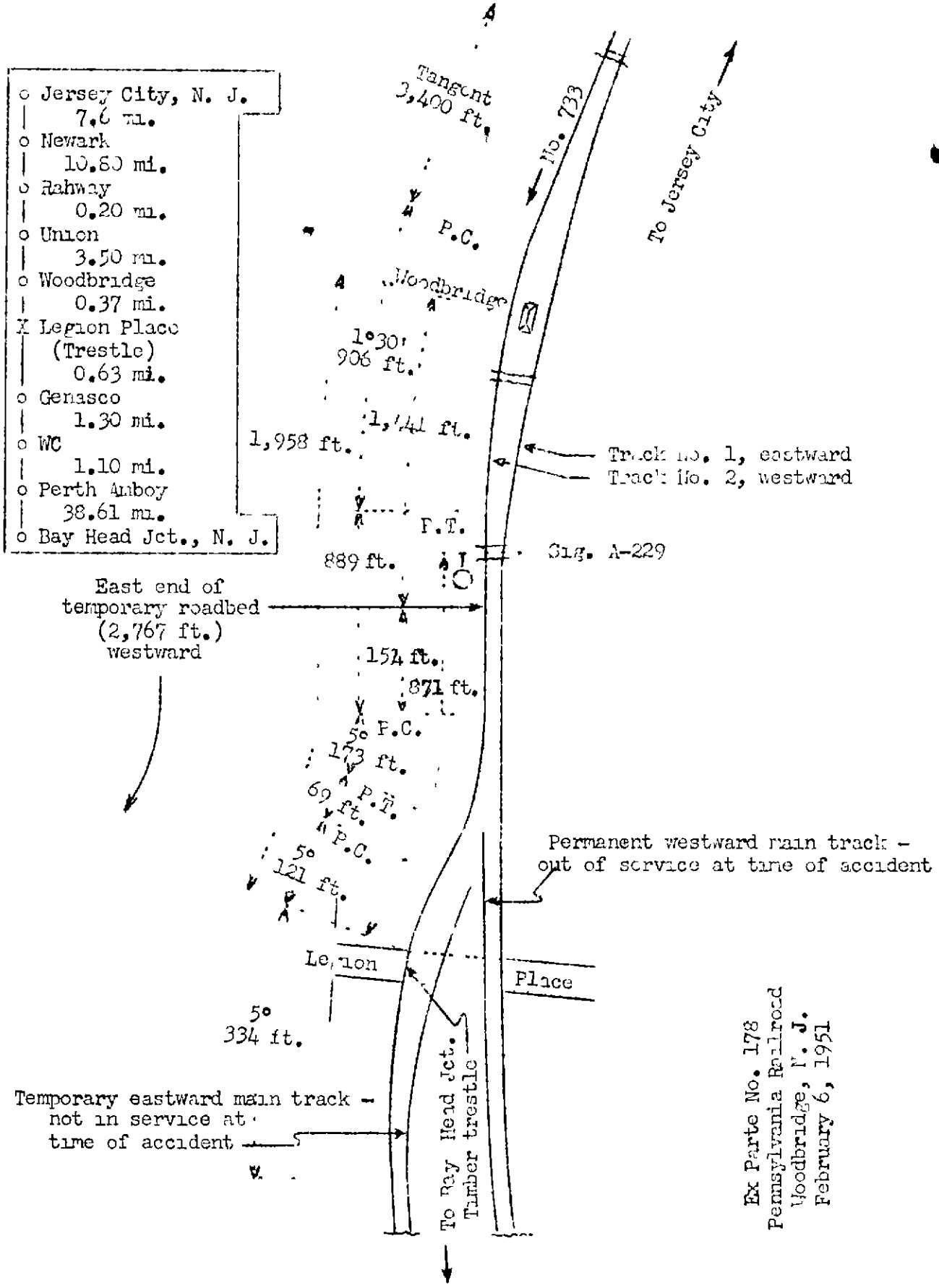
A. Schroeder for the Pennsylvania Railroad Company.
Benjamin C. Van Tine for the State of New Jersey.
W. T. McGrath, John J. Mantell and Nelson Rapp for the New Jersey Public Utility Commission.
Col. Earle Hepburn for the Department of Army Operation of Railroads.
J. Bernard McDonnell for the Jersey Shore Protective Committee.
John H. Higgins and Walter L. Woodward Jr. for the Brotherhood of Locomotive Firemen and Enginemen.
Joseph W. Levy for U. S. Senator Robert C. Hendrickson of New Jersey.
Alex Eber for the Prosecutor, Middlesex County, New Jersey.

REPORT OF THE COMMISSION

DIVISION 3, COMMISSIONERS PATTERSON, JOHNSON, AND KNUDSON

PATTERSON, Commissioner:

This is an investigation by the Commission on its own motion with respect to the facts, conditions and circumstances connected with an accident which occurred on the line of the Pennsylvania Railroad at Woodbridge, N. J., on February 6, 1951. Hearing was had at New York, N. Y., on February 8, 9, 10, and 12, 1951, at Perth Amboy, N. J., on February 10, 1951, and at Point Pleasant, N. J., on February 11, 1951. The accident was the derailment of a passenger train and resulted in the death of 33 passengers and 1 train-service employee, and the injury of 345 passengers and 5 train-service employees. Representatives of the Board of Public Utility Commissioners of the State of New Jersey sat with our representatives at the hearing.



Ex Parte No. 178
Pennsylvania Railroad
Woodbridge, N. J.
February 6, 1951

Location of Accident and Method of Operation

This accident occurred on that part of the New York Division extending between Union, near Rahway, and WC, near Perth Amboy, N. J., 5.8 miles, a double-track line, over which trains moving with the current of traffic are operated by automatic block-signal and cab-signal indications. A catenary system is provided for the electric propulsion of trains. Electric, Diesel-electric, and steam motive power are used. The main tracks from south to north are designated as No. 1, eastward, and No. 2, westward. At the time of the accident, track No. 2 was laid on a temporary roadbed between points 1,441 feet and 4,206 feet, respectively, west of the station at Woodbridge. Woodbridge is located 3.5 miles west of Union. Track No. 2 was carried over Legion Place, 1,968 feet west of the station at Woodbridge, by a 4-span timber trestle, 57 feet 10 inches in length. The accident occurred on track No. 2 near the east end of the trestle. From the east on track No. 2 there are, in succession, a tangent 3,400 feet in length, a 1°30' curve to the left 906 feet, a tangent 735 feet to the temporary track, a tangent 154 feet, a 5° curve to the right 173 feet, a tangent 69 feet, and a 5° curve to the left 121 feet to the trestle and 534 feet westward. The grade for west-bound trains is, successively, level 3,200 feet, 0.20 percent ascending 1,100 feet, and 0.64 percent ascending 1,208 feet to the trestle and a considerable distance westward.

The east approach to the trestle consisted of a clay fill approximately 15 feet in height placed in 1948. The back-fill to the abutment was constructed about December 1, 1950 of sandy loam placed in layers and mechanically tamped. The structure of the temporary track consisted of 131-pound rail, rolled in 1942 and cropped to 36-foot lengths in 1950. It was laid on an average of 20 treated ties to the rail length, fully tieplated with double-shoulder heavy duty tieplates, and was spiked with 2 rail-holding spikes and 1 anchor spike per tieplate. It was provided with 36-inch 6-hole joint bars with 4 bolts per rail joint and 6 rail anchors per rail. It was ballasted with 18 inches of crushed stone approximately 386 feet and then with 12 inches of cinders about 190 feet to the abutment.

The timber trestle consisted of 2 spans, 14 feet 6 inches in length, and 2 spans, 14 feet 3 inches in length, supported by a permanent concrete abutment at each end and 3 untreated southern pine pile bents. Each bent consisted of 2 vertical piles and 4 batter piles with 3-inch by 10-inch cross braces in each direction, surmounted by 14-inch by 14-inch untreated fir caps and three 10-inch by 20-inch untreated fir stringers under each track rail. Each end bent was braced longitudinally

against the abutment by two 6-inch by 10-inch braces. The bridge ties were 8-inch by 10-inch untreated fir spaced 16 inches between centers and were tapered an average of about 1/2 inch for each set of stringers. Guard timbers were 6-inch by 8-inch untreated fir, dapped 1 inch for each tie and fastened to alternate ties by 5/4-inch lag screws 11 inches in length. Walkways were located outside of each guard timber and between the track guard rails and were constructed of 2-1/2-inch fireproofed planks. Two 100-pound inner guard rails, placed between the track rails, extended between points 105 feet east and 40 feet west of the trestle.

This carrier's operating rules read in part as follows:

75. General orders will be issued by authority and over the signature of the superintendent. General orders must be numbered consecutively, the number being prefixed by the number of the time-table. Each general order will contain a sub-heading indicating in what general order zone or zones the order applies.

75b. Conductors and enginemen, when reporting for duty, must examine the bulletin boards to see that they are familiar with all effective general orders pertaining to any portion of the general order zones on which they are qualified. They must insert a sticker copy of all general orders in their time-tables, after which they, as well as trainmen and firemen, must sign the employes' register in the presence of a designated employe who must personally witness the signature of each employe.

Train and engine crews after having been off duty one hour or more, must re-register.

* * *

Before starting on a trip or tour of duty, the conductor and engineman must know that the other is qualified and that he has inserted in his time-table the necessary general orders for such trip or tour of duty, also the conductor must know with respect to the trainmen, and the engineman, with respect to the fireman, that they have seen and are familiar with such general orders.

* * *

Each qualified conductor and engineman * * * must have with him while on duty the time-tables of the divisions on which he is qualified in part or whole showing the general order zones in which he is qualified and containing the necessary general orders pertaining thereto.

Supplemental Instructions to Operating, Signal and Interlocking Rules read in part as follows:

Slow Orders

1078-A. A yellow flag or light placed to the right of track indicates the approach to a portion of track covered by a slow order and is located a sufficient distance ahead of the obstruction to permit the speed of train to be reduced from maximum authorized speed to the speed required.

The end of the restricted territory will be indicated by a green flag or light.

Train Orders Used for Slow Orders--Re-issuing, etc.

4208-A. Train orders used for slow orders or similar instruction shall be in effect only a sufficient length of time to prepare a general order unless the length of time the restriction will be in effect is known and it would be impracticable to provide a general order.

During the time such train orders are used, they should be re-issued each day, as soon as practicable after 12:01 A. M.

Automatic signal A-229, governing west-bound movements on track No. 2, is located 871 feet east of the trestle. This signal is of the position-light type and displays three aspects.

The maximum authorized speed was 65 miles per hour for passenger trains, but was restricted to 25 miles per hour over the temporary track.

Description of Accident

No. 733, a west-bound first-class passenger train, consisted of engine 2645, 10 coaches and 1 club car, in the order named. All cars were of all-steel construction. This train was en route from Jersey City, 19.6 miles east of Union, to Bay Head Jct., 39.71 miles west of WC. Before leaving Jersey City, the conductor and the engineer had received copies of General Order No. 1806 reading in part as follows:

* * *

Effective 1.01 P.M., Tuesday, February 6, 1951

Applies in Zone C

(i) PERTH AMBOY AND WOODBRIDGE BRANCH
WOODBRIDGE--GENASCO
No. 2 main track and catenary moved 50 feet northward between a point 1000 feet west of Woodbridge Station and a point 4000 feet west of Woodbridge Station. Trains and engines must not exceed a speed of 15 miles per hour between these points. * * *

* * *

This train departed from Jersey City at 5,10 p. m., on time, passed Union, the last open office, at 5:36 p.m., 1 minute late, passed signal A-229, which indicated Proceed, and while moving at a speed of about 50 miles per hour the engine, the tender, the first seven cars, and the front truck of the eighth car were derailed at or near the trestle.

The engine stopped on its right side, 7.5 feet north of and parallel to the track, with its front end 280 feet west of the west end of the trestle. It was somewhat damaged. The tender stopped upside down at the foot of the fill and opposite the front end of the engine. The first car stopped upright, with the west end 60 feet north of the track and against the side of the tender, and the east end 40 feet north of the track. The center sills were broken, and both vestibules were crushed inward. The second car stopped on its right side, parallel to the track, with the west end against the east end of the first car. The center sills were broken, and the right side of the car was crushed inward. The third car stopped on its side, behind the second car, with the west end 25 feet north of the track and the east end 75 feet north of the track. The center sills were broken, and both sides and the roof were badly damaged. The fourth car stopped upright west of the third car and approximately in line with the track. The right side was torn open throughout the length of the car, both vestibules were crushed inward and the center sills were broken. The fifth car stopped with the west end against the east end of the fourth car, and the east end 30 feet north of the track. It leaned to the north at an angle of about 35 degrees. The right front corner was torn out, and the rear end was bent inward and downward. The sixth car stopped with the west end against the east ends of the third and the fifth

cars, and the east end about 5 feet north of the track. It leaned to the north at an angle of 30 degrees. The center sills were broken, the right front corner was torn out, and the right side was bent inward at the center. The seventh car stopped with the west end against the east end of the engineer, and had set end on the track structure. It leaned to the north at an angle of 10 degrees. The center sills were intact. The eighth car stopped upright and in line with the track. It was slightly damaged.

The fireman was killed, and the engineer, the conductor, and three brakemen were injured.

The weather was cloudy, and it was dark at the time of the accident, which occurred about 5:47 p. m.

Engine 1245 was a steam locomotive of the 4-6-2 type. The specified diameters of the engine-truck wheels, the driving wheels, and the trailing-truck wheels were, respectively, 36 inches, 80 inches, and 50 inches. The driving wheelbase was 10 feet 10 inches, the total length of the engine and tender, coupled, was 84 feet 6-1/2 inches. The total weights of the engine and the tender in working order were, respectively, 320,000 pounds and 251,400 pounds. The calculated safe and overturning speeds of engine 1245 on a 5-degree curve with full superelevation were, respectively, 44 and 78 miles per hour. The calculated safe and overturning speeds of the tender on the same curve with the estimated amounts of fuel and water remaining when the accident occurred were, respectively, 49 and 84 miles per hour.

All the cars in train No. 753 were Class P-70 conventional all-steel cars. The design and construction of these cars were such that they met or exceeded present minimum strength requirements of the Association of American Railroads for new passenger cars, which requirements were adopted as standard in 1941.

Discussion

In connection with a bridge construction project west of the station at Woodridge, it was necessary that a section of the two permanent main tracks be taken out of service during a period of several months. During this period trains were to be operated over two temporary tracks which were laid north of, and approximately parallel to, the permanent tracks. On the day of the accident, the ends of the northerly temporary track were

connected to track No. 2 at points, respectively, 1,441 feet and 4,208 feet west of the station at Woodbridge. After 1.01 p. m. the temporary track was used as track No. 2, and the permanent westward main track between the ends of the temporary track was taken out of service. It was planned to use the southerly temporary track as track No. 1 after 1:01 p. m. February 6, 1951, and to take the permanent eastward main track out of service at that time. General Order No. 1806, instructing train and engine crews affected as to these track changes and restricting the speed of trains to 20 miles per hour while moving over the temporary tracks, was issued January 29, 1951. Between 1.01 p. m. February 6 and the time the accident occurred, eight west-bound trains passed over track No. 2. These trains were, in the order named, an engine of the same class as the engine of No. 736, a passenger train consisting of an electric locomotive and nine cars, a freight train consisting of a Diesel-electric locomotive and two cars, a passenger train consisting of an electric locomotive and nine cars, a passenger train consisting of an electric locomotive and 10 cars, a passenger train consisting of eight multiple-unit cars, a passenger train consisting of an engine of the same class as the engine of No. 736 and 12 cars, and a passenger train consisting of eight multiple-unit cars.

No. 736 departed from Jersey City on time and passed Union, the last open office, 1 minute late. As this train was approaching the point where the accident occurred, the engineer and the fireman were in the cab of the engine, the conductor was in the first car, the flagman was in the tenth car, and the other members of the train crew were in various locations throughout the cars of the train. The headlight was lighted brightly. The brakes of this train had been tested and had functioned properly when used en route. The engineer testified that he closed the throttle when the train was about 1 mile east of Woodbridge, and that he made a brake-pipe reduction of between 8 and 10 pounds when the train was closely approaching the station at Woodbridge. He estimated that the speed of the train was about 60 miles per hour when he closed the throttle, and was about 50 miles per hour when he made the brake-pipe reduction. The engine was not equipped with a speed indicating or recording device. He testified that he was aware that the speed of the train was restricted to 20 miles per hour on the temporary tracks and he was maintaining a lookout ahead for warning signals to indicate the point at which the restriction became effective. He estimated that

the speed of the train was about 25 miles per hour when it entered the temporary track. The conductor testified that the train was moving at normal speed as it approached Woodbridge. He thought the speed was too high in the vicinity of the station at Woodbridge for operation over the temporary track. He was not aware of any reduction in speed and did not feel any application of the brakes. However, the derailment occurred before he could take action to stop the train. The flagman testified that immediately before the accident occurred he did not notice any reduction in speed nor feel any application of the train brakes.

After the derailment occurred, marks on the track structure and the position of the engine indicated that the engine did not overturn until immediately before it stopped. Marks on the trucks of the tender indicated that both trucks had been derailed before they reached the west end of the trestle and had struck the concrete abutment. Splinters of lumber which were identified as a part of the footwalk of the trestle were wedged into the No. 1 brake beam of the front truck. Traces of concrete were found in the front leg of the right front pedestal of both the front and the rear trucks, and both the pedestal legs and the truck sides were badly bent. Both trucks were torn from the tender. The underframe of the tender was cast-steel with integral body bolsters. The underframe was broken in the accident and a portion about 13 feet in length, including the front body bolster, remained attached to the engine by the drawbar safety bar. The drawbar between the engine and the tender was broken, and the drawbar and the safety bar were twisted clockwise. Some of the baffle boards in the cistern of the tender were broken, but the breaks were new and apparently occurred as a result of the derailment. Examination of the engine, the tender, and the cars of the train disclosed no condition that would have caused or contributed to the cause of the derailment.

Examination of the track after the accident occurred disclosed no indication of dragging equipment. The track structure on the first curve of the temporary track was displaced to the south a maximum distance of 6-1/2 inches. At a point about 72 feet east of the east end of the trestle, the north rail was pulled apart at a rail joint. From this point westward the track was destroyed throughout a distance of about 275 feet. The track structure on the trestle was displaced to the outside of the curve and clear of the trestle. The north batter pile of the westerly bent of the trestle was broken, the north ends of the caps were splintered and cut, the two outside stringers on the north side of the trestle

were cut by wheel flanges, and the north stringer was broken at each end of the trestle. With the exception of this damage, which was caused by the derailment, the trestle was found to be in its original structural condition and alinement. The top of the westerly abutment north of the track had been struck and damaged by derailed equipment. Because the track was destroyed throughout a considerable distance on either side of the trestle, it could not be determined which unit of the train was the first to become derailed or the exact point of its derailment.

The track on the curve to the right which was displaced a maximum of 6-1/2 inches was ballasted with crushed stone to a depth of 18 inches. On each side of the trestle the track on the curve on which the accident occurred was ballasted with cinders to a depth of 12 inches. Chafe marks on the upper south edge of the south stringer of the trestle indicated that the dapped bridge ties had been pulled laterally to the north. However, no such marks appeared throughout a distance of about 6 feet immediately west of the east end of the trestle. The engineer testified that the engine seemed to slip to one side in the vicinity of the trestle, and it was his opinion that the tender was the first unit to become derailed. The damage to the equipment of No. 733 and the locations of the units after the derailment occurred indicate that the speed was about 50 miles per hour when the accident occurred. Both the conductor and the flagman testified that they did not notice any reduction in speed immediately before the derailment occurred. It is apparent that the track structure immediately east of the east abutment of the trestle was displaced to the outside of the curve and also was depressed in the cinder ballast by the engine of No. 733. When the engine was closely approaching the trestle, the lateral force on the track toward the outside of the curve was transmitted ahead of the engine-truck wheels to the track structure on the trestle through the track rails. The absence of chafe marks on the south stringer immediately west of the east abutment indicates that the first ties were raised, probably by the fulcrum action of the concrete abutment, sufficiently to permit their lateral movement on the stringers. After the lateral movement of the track was started at the east end of the trestle, the 1/2-inch daps in the ties did not afford sufficient resistance to prevent the lateral movement of the track throughout the length of the trestle. The fact that the engine continued in line with the track a distance of about 280 feet west of the trestle indicates that it was not entirely derailed until after it crossed the trestle. However, the track evidently was a considerable distance

out of alinement when the engine passed the west abutment. With the track in normal alinement, the drawbar and the safety bar between the engine and the tender, which were 41 inches long, would have prevented the tender from moving laterally a sufficient distance to strike the abutment. After the track shifted laterally on the stringers, it did not afford sufficient support for the train, and the general derailment followed.

On the temporary track on which this accident occurred, a superelevation of only 1 inch was provided on the 5-degree curves because of the limited space available for the construction of spirals to the curves. The track structure on the approach to the trestle was ballasted with cinders to a depth of about 12 inches and it was necessary to raise the track about 1/2 inch after the third train passed over it, at which time the ballast was shovel-tamped. Cinder ballast does not provide the same resistance against lateral forces exerted against the track structure nor does it distribute vertical loads to the sub-grade as does stone ballast. Two consulting civil engineers, specializing in bridge design and construction, testified that they examined the plans for the construction of the trestle at Woodbridge and that the design was adequate for the service for which the trestle was intended. They were familiar with the specifications of the American Railway Engineering Association which provide that every third tie be anchored to the stringer by boat spikes extending through the tie and about 4 inches into the stringer. It was the opinion of each that the dapping of bridge ties, which is standard practice on the Pennsylvania Railroad, provides greater resistance to lateral thrusts on the track structure than does the anchoring of every third tie by boat spikes. However, this type of construction, especially on curves, requires that the track immediately in approach of the trestle be maintained within close limits, both in alinement and surface, to insure that abnormal lateral thrusts are not exerted against the track structure at the abutment.

Crews of Pennsylvania Railroad trains operating between Jersey City and Bay Head Jct. are governed by the operating rules of the Pennsylvania Railroad between Jersey City and WC, 24.4 miles, and by the operating rules of the New York and Long Branch Railroad between WC and Bay Head Jct., 69.71 miles. On the New York Division of the Pennsylvania Railroad when a general order can be issued sufficiently in advance of the time a speed restriction is to be effective, neither train orders nor a warning signal placed in approach of the point of restriction are required. On the New York and

Long Branch Railroad warning signals are used to indicate the limits of speed restriction areas. The engineer of No. 73[illegible] had been the assigned engineer of this train during a period of about two weeks before the accident occurred, but he had been assigned to other trains operating in this territory during the last 12 years. He testified that he had discussed General Order No. 1806 with the conductor before the train departed from Jersey City, but, because he was accustomed to the use of warning signals on the New York and Long Branch Railroad to indicate the limits of speed restriction areas between WC and Bay Head Jct., he overlooked the fact that they would not be used between Union and WC.

General Order No. 1806 pertained to changes in schedules, signaling, special instructions, and speed restrictions on the New York Division. Conductors and engineers are required to be familiar with all general orders pertaining to any portion of the division on which they are qualified. When a general order can be issued sufficiently in advance of the time a speed restriction is to become effective, neither train orders nor a warning signal placed in approach of the point of restriction are required to be used. Warning signals or speed-limit signs used to indicate the limits of speed restriction areas serve as a reminder to engine crews that their train immediately will enter a speed restriction area, and also will define the limits of the restriction. These signs, properly located, would provide an additional safeguard against failure to comply with a speed restriction.

During the 30-day period preceding the day of the accident, the average daily movement in the vicinity of the point of accident was 61.7 trains of which 70 percent were passenger trains. This line is equipped with automatic block-signal and cab-signal systems. However, these systems were arranged originally to indicate track occupancy and neither system was arranged to display a restrictive aspect to govern movements over the temporary track. It was expected that the temporary track would be in service during a period of about 6 months. The Pennsylvania Railroad Company has announced that it will install an automatic speed-control system on those portions of the line of greatest traffic density. This system, also known as automatic train control, automatically and continuously will enforce certain prescribed speed limits and is the best system yet devised for that purpose. In addition to its primary function of controlling the speed of a train when such control is required by reason of track occupancy by a preceding or opposing train, the controlling circuits can be arranged to provide protection over a temporary track or similar conditions where a speed restriction is required.

Cause

It is found that this accident was caused by excessive speed on a curve of a temporary track.

Recommendation

We recommend that the Pennsylvania Railroad Company install an automatic train-control system, in accordance with their public announcement, and that it first install such system on its New York Division where such system will automatically and continuously enforce a speed restriction of not exceeding 20 miles per hour while proceeding through a block occupied by a preceding or opposing train and so arranged that it will enforce, in like manner, a safe speed under temporary conditions similar to those which existed at Woodbridge when this accident occurred. We further recommend that the carrier provide adequate warning signs to indicate to enginemen the limits of temporary speed restriction areas on its line unless such restricted areas are protected by automatic train-control.

By the Commission, Division 3.

(SEAL)

W. P. BARTEL,

Secretary.