INTERSTATE COMMERCE COMMISSION

Ex Parte No. 181

ACCIDENT NEAR BRYN MAWR, PA.

Submitted May 24, 1951 Decided June 14, 1951

Accident near Bryn Mawr, Pa., on May 18, 1951, caused by failure to operate the following train in accordance with signal indications.

Recommended that a train-control system be installed.

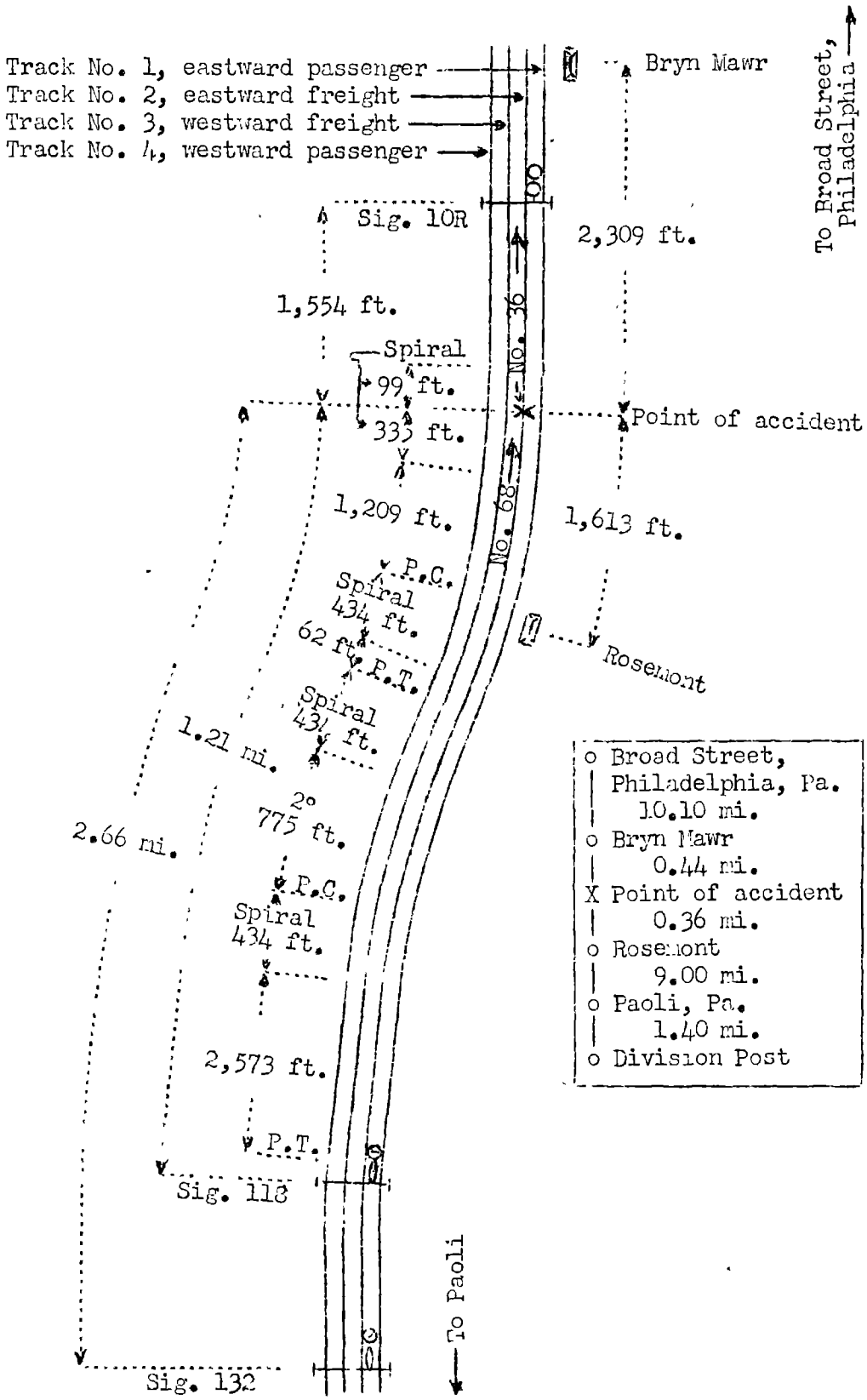
A. Schroeder for the Pennsylvania Railroad Company.
Col. Earle Hepburn for the Department of the Army Operation of Railroads.
Charles M. Phillips, Walter B. Woodward, Jr., and John J. Higgins for the Brotherhood of Locomotive Firemen and Enginemen.
Edward B. Henslee, Jr., for Brotherhood of Railroad Trainmen.

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 near Bryn Mawr, Pa., on May 18, 1951. Said investigation and an investigation by the Pennsylvania Public Utility Commission were heard on a common record. Hearing was had at Philadelphia, Pa., on May 23 and 24, 1951. The accident was a rear-end collision between two passenger trains and resulted in the death of 7 passengers and 1 Pullman employee, and the injury of 95 passengers, 14 Pullman employees, 8 dining-car employees, and 6 train-service employees.



Ex Parte No. 181
Pennsylvania Railroad
Bryn Mawr, Pa.
May 18, 1951

Location of Accident and Method of Operation

This accident occurred on that part of the Philadelphia Terminal Division extending between Division Post, near Paoli, and Broad Street, Philadelphia, Pa., 21.3 miles. In the vicinity of the point of accident this is a four-track line. The main tracks from south to north are designated as No. 1, eastward passenger; No. 2, eastward freight; No. 3, westward freight; and No. 4, westward passenger. Trains moving with the current of traffic on tracks Nos. 1, 2, and 4, and trains moving in either direction on track No. 3, are operated by automatic block-signal and cab-signal indications. A catenary system is provided for the electric propulsion of trains. The accident occurred on track No. 2 at a point 9.36 miles east of Paoli and 2,309 feet west of the station at Bryn Mawr. From the west there are, in succession, a tangent 2,573 feet in length, a spiral 434 feet, a 2° curve to the right 775 feet, a spiral 434 feet, a tangent 62 feet, a spiral 434 feet, a 2° curve to the left 1,209 feet, and a spiral 335 feet to the point of accident and 99 feet eastward. The grade for east-bound trains is, successively, 0.53 percent descending 1,377 feet, 0.76 percent descending 3,340 feet, 0.18 percent descending 503 feet, and 0.5 percent ascending 1,166 feet to the point of accident.

Automatic signals 132 and 118 and semi-automatic signal 10R, governing east-bound movements on track No. 2, are located, respectively, 2.66 miles west, 1.21 miles west, and 1,554 feet east of the point of accident. These signals are of the position-light type. Signals 118 and 10R each display a yellow triangle outlined in black. The aspects applicable to this investigation and the corresponding indications and names are as follows:

Signal	Aspect	Indication	Name
132 118	Three amber lights in diagonal position to the right.	Proceed prepared to stop at next signal. Train exceeding Medium speed must at once reduce to that speed.	Approach.
118	Three amber lights in horizontal position over one amber light.	Stop; then proceed at Restricted speed.	Stop-and-proceed.

10R	Three amber lights in horizontal position over three amber lights in vertical position.	Proceed; Medium speed within interlocking limits. NOTE--Trains may proceed at not exceeding 45 miles per hour within interlocking limits, at signals displaying a yellow triangle outlined in black.	Medium-clear.
10R	Three amber lights in horizontal position.	Stop.	Stop-signal.

The cab signals are of the continuous-inductive, four-indication, position-light type. The cab signals on each electric locomotive are so arranged that their aspects may be observed by either the engineer or the fireman from their accustomed positions in the control compartment. The aspects applicable to this investigation and the corresponding indications and names are as follows:

Aspect	Indication	Name
Three white lights in vertical position.	Proceed.	Clear.
Three white lights in diagonal position to the right over three white lights in vertical position.	Proceed approaching next signal at Medium speed. NOTE--Trains may proceed approaching next signal at not exceeding 45 miles per hour at signals displaying a yellow triangle outlined in black.	Approach-medium.
Three white lights in diagonal position to the right.	Proceed prepared to stop at next signal. Train exceeding Medium speed must at once reduce to that speed.	Approach.

Two white lights in diagonal position to the left.	Proceed at Restricted speed.	Restricting.

The controlling circuits are so arranged that when the block of signal 118 is occupied, signal 132 indicates "Approach" and signal 118 indicates "Stop-and-proceed." The cab-signal system is so arranged that when a train enters or is proceeding through a block which is clear of other trains and the signal in advance indicates "Clear" or "Approach," the cab signal indicates "Clear." If the signal in advance indicates "Medium-clear," the cab signal indicates "Approach-medium." If the signal in advance indicates "Stop-and-proceed" or "Stop," the cab signal indicates "Approach." When a train enters or is proceeding through a block which is occupied by a preceding train, the cab signal indicates "Restricting." The cab signal also indicates "Restricting" throughout a distance of about 750 feet immediately west of signal 10R if the indication of signal 10R is less favorable than "Approach." When a cab signal changes to a more restrictive aspect, a warning whistle in the cab sounds until acknowledged by the engineer.

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

DEFINITIONS

Medium Speed--Not exceeding one-half the speed authorized for passenger trains but not exceeding 30 miles per hour.

Restricted Speed--Not exceeding 15 miles per hour prepared to stop short of train, obstruction or switch not properly lined and to look out for broken rail.

29. When a signal, except a fixed signal, is given to stop a train, it must be acknowledged * * *

35. The following signals will be used by flagmen:

Day signals--A red flag, torpedoes and fusees.
* * *

99. When a train stops under circumstances in which it may be overtaken by another train, the flagman must go back immediately with flagman's signals a sufficient distance to insure full protection, placing two torpedoes, and when necessary, in addition, displaying lighted fusees.

* * *

Note.--When trains are operating under Automatic Block System Rules, the requirements of Rule 99, in so far as protecting against following trains is concerned, will have been complied with when full protection is afforded against trains moving at Restricted speed.

296. Cab signal indications do not supersede fixed signal indications except when cab signal changes to a more restricting or a more favorable indication after passing a fixed signal.

298. Should cab signal and fixed signal indications conflict, the more restrictive indication will govern.

* * *

The maximum authorized speed for passenger trains was 70 miles per hour.

Description of Accident

No. 36, an east-bound first-class passenger train, consisted of electric locomotive 4868, 5 storage mail cars, 2 express cars, 1 combination passenger-baggage car, 1 coach, and 10 sleeping cars, in the order named. All cars were of standard all-steel construction except the tenth, twelfth, thirteenth, fourteenth, sixteenth, and eighteenth cars, which were of lightweight steel construction. This train departed from Paoli on track No. 1 at 6:21 a. m., 41 minutes late, and was diverted to track No. 2 immediately east of the station. It passed signal 118, which indicated "Approach," and stopped about 6:32 a. m. at signal 10R, which indicated "Stop." The rear end of the train stopped 1.21 miles east of signal 118. About 7 minutes later the rear end was struck by No. 68.

No. 68, an east-bound first-class passenger train, consisted of electric locomotive 4839, 1 dormitory sleeping car, 1 baggage car, 2 coaches, 2 sleeping cars, 1 dining car, and 3 sleeping cars, in the order named. The first, second, fifth, and seventh cars were of standard all-steel construction, and the other cars were of lightweight steel construction. This train departed from Paoli on track No. 4 at 6:24 a. m., 5 minutes late, and was diverted to track No. 2 immediately east of the station. It passed signal 132, which indicated "Approach," and stopped at signal 118, which indicated "Stop-and-proceed." It then proceeded eastward, and while moving at an estimated speed of 40 miles per hour it struck the rear end of No. 36.

No. 36 was moved eastward approximately 100 feet by the force of the impact. The chassis of the locomotive of No. 68 passed under the underframe of the rear car of No. 36 and stopped in line with track No. 2, with its front end under the center of the eighteenth car and 230 feet east of the point of accident. The underframe of the rear car of No. 36, which was forced between the cab structure and the chassis of the locomotive, tore the cab structure from the chassis. The entire superstructure of this car was sheared off and demolished by the cab structure of the locomotive. The next to the rear car of No. 36 was derailed and stopped with its rear end on track No. 1 and its front end on track No. 2. It leaned toward the south at an angle of about 60 degrees. This car was badly damaged, and the locomotive and the first, eighth, ninth, sixteenth, and seventeenth cars of No. 36 were damaged. The first, second, third, fourth, and seventh cars of No. 68 were damaged.

The engineer, the fireman, and the brakeman of No. 68 and the conductor, the engineer, and the baggageman of No. 36 were injured.

The weather was clear and it was daylight at the time of the accident, which occurred at 6:39 a. m.

Discussion

No. 36 departed from Paoli on track No. 1 at 6:21 a. m., and immediately was diverted to track No. 2. After the train entered track No. 2 both the roadway signals and the cab signals indicated "Clear" between Paoli and signal 118, which indicated "Approach." After the locomotive passed signal 118 the cab signals indicated "Approach" until the locomotive was about 750 feet west of signal 10R when they indicated "Restricting" because signal 10R indicated "Stop." The train was stopped at signal 10R about 6:32 a. m., the train brakes were released and the independent brake was applied. Immediately after the train stopped, the fireman proceeded to a booth telephone in the vicinity of signal 10R where he communicated with the operator at Bryn Mawr interlocking. He was informed by the operator that No. 36 had actuated a dragging equipment detector near signal 132, which caused signal 10R to indicate "Stop," and was instructed to inspect the train for dragging equipment. The engineer, the fireman, and the conductor then proceeded to inspect the train. When the train stopped, the flagman obtained a red flag, torpedoes and a fusee from the front end of the rear car and proceeded westward to provide protection. He testified that he was about 600 feet west of the rear end of his train when he heard a train approaching

from the west. He proceeded on track No. 1 so that stop signals would be visible at a greater distance than if given from track No. 2. He saw the approaching train on track No. 2 at a distance of about 1,000 feet and gave stop signals with a red flag. When No. 68 was about 100 feet west of him the engineer sounded one blast on the engine whistle. As the locomotive passed the flagman, he saw the engineer arise from his seat and look through the front window of the cab. The flagman testified that the brakes of No. 68 were applied when the locomotive was about 200 feet east of him.

The brakes and the cab-signal equipment of No. 68 were tested before that train departed from Harrisburg; 83.4 miles west of Paoli, and they functioned properly between Harrisburg and Paoli. This train arrived at Paoli on track No. 2 at 6:21 a. m. and was diverted to track No. 4. The roadway signal governing the movement from track No. 2 to track No. 4 indicated "Restricting." After the locomotive passed the roadway signal the cab signal also indicated "Restricting" and the cab-signal whistle sounded until it was acknowledged by the engineer. Station work was performed on track No. 4 at Paoli and the train departed from that station at 6:24 a. m. and was diverted to track No. 2. The cab signal indicated "Restricting" until the locomotive passed through the interlocking. At that time the cab-signal indication changed to "Approach." While the train was proceeding through the block, the cab-signal indication changed to "Clear." The next signal indicated "Approach," the cab-signal indication changed to "Approach" when the locomotive passed the signal, and the cab-signal whistle sounded until it was acknowledged by the engineer. While the train was proceeding through the block the cab-signal indication changed to "Clear." The next two roadway signals indicated "Clear" and the cab signal continued to indicate "Clear." While the train was proceeding through the two clear blocks the fireman left the cab to adjust the steam heat apparatus and was not in position to observe the cab-signal aspects. Signal 132 indicated "Approach," the cab signal indicated "Approach" after the locomotive passed the signal and the cab-signal whistle sounded until it was acknowledged by the engineer. The indication was called by the engineer and was repeated by the fireman. Signal 118 indicated "Stop-and-proceed" and the train was stopped about 75 feet west of the signal. All members of the crew of No. 68 testified that signal 118 indicated "Stop-and-proceed" except the baggageman who did not observe the signal. The fireman testified that he observed the signal from the engineer's side of the cab and then proceeded to the fireman's side before the train passed the signal; that the cab signal indicated "Approach-medium" immediately after the locomotive passed the signal and continued to display that aspect within the block; that the engineer called the "Approach-

medium" indication to him, and that the speed then was increased to about 40 miles per hour. The engineer testified that the cab signal immediately indicated "Restricting" after the locomotive passed signal 118, the cab-signal whistle sounded and was acknowledged by the engineer, and the indication was called to the fireman and repeated by him; that after the locomotive was about 200 feet east of the signal the cab-signal aspect changed to "Approach" and the indication was called to the fireman and repeated by him; that the speed then was increased to about 30 miles per hour; that after the train was about 1,000 feet east of signal 118 the cab-signal aspect changed to "Approach-medium" and this indication was called to the fireman and was repeated by him; and that the speed then was increased to about 45 miles per hour. The fireman testified that he first saw the flagman of No. 36 when the locomotive was in the vicinity of Rosemont station, 1,613 feet west of the point of accident, and called a warning to the engineer who immediately made an emergency brake application. The engineer testified that the fireman called the warning when the locomotive was adjacent to Rosemont station and that he first made a service application. Immediately afterward the engineer saw the flagman at a distance of about 150 feet and made an emergency application. The speed was not materially reduced before the collision occurred.

The first train to move eastward on track No. 2 after the accident occurred was a work extra which departed from Paoli at 11:35 a. m. and arrived at the scene of the accident at 12:10 p. m. At that time neither train involved in the accident had been moved. Both the engineer and the fireman testified that signal 132 indicated "Approach" and that the cab signals indicated "Approach" when the locomotive entered the block of signal 132. Signal 118 indicated "Stop-and-proceed" and when the locomotive entered the block of signal 118 the cab signal indicated "Restricting" and continued to indicate "Restricting" while the locomotive was occupying the block. This train moved the undamaged cars of No. 68 to Paoli. The next train to move eastward on track No. 2 was a work extra which departed from Paoli at 1:49 p. m. and arrived at the scene of the accident at 2:30 p. m. Both the engineer and the fireman testified that the roadway and cab signals functioned properly. The third east-bound movement over track No. 2 was locomotive 4903 of the same class as the locomotive of No. 68. It departed from Paoli at 5:10 a. m., May 19, and arrived at the scene of the accident about 5:26 a. m. At that time a train had been placed on track No. 2 at the point of collision. The road foreman of engines, who was operating the locomotive, testified that signals 132 and 118 and the cab signal of locomotive 4903 functioned properly.

The supervisor of telegraph and signals testified that about 7:15 a. m. on the day of the accident he instructed employees of the signal and telegraph department to proceed to signals 118 and 132 and observe the indications displayed by those signals. About 7:35 a. m. these employees reported to him that signal 132 indicated "Approach" and that signal 118 indicated "Stop-and-proceed". He then instructed them to seal all instrument cases housing apparatus controlling signals 132 and 118. The cases were opened the following day when all relays and other apparatus were tested. The operating characteristics of all relays were within the limits for which they were designed to operate. All wires were tested for insulation resistance and track circuits on track No. 2 were tested for shunting sensitivity. No condition was found which would have caused or contributed to cause a false-proceed automatic-block or cab-signal indication. No roadway signal apparatus was damaged as a result of the accident. Signals 132 and 118 were kept under continuous observation throughout a period of 72 hours after the accident occurred during which time they functioned as intended.

The cab-signal relays and amplifier on the locomotive of No. 68 were housed in the trailing end when the collision occurred and were not damaged in the accident. The equipment box was sealed after the accident occurred and was opened about 3 p. m. on the following day. At that time all relays were deenergized. The only equipment which was damaged as a result of the collision was the receiver on the leading end of the locomotive and the directional switch. All of the undamaged equipment was removed from the locomotive and was tested at the carrier's repair shop at Wilmington, Del., and found to be functioning as intended. The undamaged equipment then was installed on locomotive 4871, of the same class as the locomotive of No. 68, the undamaged receiver from the trailing end of the locomotive of No. 68 was installed on the front end of locomotive 4871 which was operated from Wilmington to Philadelphia, 26.6 miles, thence to Paoli, and then on track No. 2 to Bryn Mawr. A train previously had been placed on track No. 2 at the point of collision. Throughout this test the cab signals functioned properly.

When signal 10R indicates "Stop", non-coded energy of 100-cycle frequency is fed to the rails of track No. 2 at the signal. At a point about 750 feet west of the signal, means are provided to transmit coded energy westward at the rate of 75 interruptions per minute. A code-following track relay is provided at a cut-section, 3,970 feet west of signal 10R, and energy of the same code and frequency which operates this relay is transmitted westward to signal 118 to operate the code-following track relay at that point. With this circuit

arrangement, energy to operate the track relays at signal 118 and at the cut-section is obtained from the same sources as that which actuates the cab-signal apparatus of an east-bound locomotive while occupying the respective track circuits. As a result, any condition of the roadway equipment to cause a false-proceed cab-signal indication would, in like manner, cause a false-proceed indication by signal 118. However, signal 118 indicated "Stop-and-proceed." The track circuit in approach to signal 10R was occupied by No. 36 both while No. 68 was approaching signal 118 and while it was proceeding through the block of signal 118. When tested for shunting sensitivity, the relay at the cut-section dropped away with a track shunt of 0.17 ohm resistance and the relay at signal 118 dropped away with a track shunt of 0.13 ohm resistance. The values obtained were well within the Commission's requirements of not less than 0.06 ohm resistance for this test. Under these conditions, the track circuit energy should have been removed from the track rails to the rear of No. 36 and the track relays at signal 118 and at the cut-section should have been deenergized, signal 118 should have indicated "Stop-and-proceed", and the cab signals should have indicated "Restricting." Throughout the 3-day period that the signal system was under continuous observation, AC code meters were connected to the track rails at the entering end of each track circuit in the block of signal 118 and there was no indication of coded energy to the rear of any of the 67 east-bound movements which occupied the block and there was no indication of foreign current of any frequency in either track circuit. All of the undamaged cab-signal apparatus on the locomotive was tested and no condition was found to cause a false-proceed indication. The apparatus then was installed on another locomotive and functioned properly throughout a test run of more than 50 miles which included the block of signal 118. The observations and tests of the automatic block-signal and cab-signal systems all indicate that they functioned properly. In addition, the testimony of the engineer and the fireman of No. 68, the only persons in position to observe the cab-signal aspects, was conflicting. The fireman testified that the cab signal indicated "Approach-medium" immediately after the locomotive passed signal 118, that the indication was called by the engineer, that the cab-signal whistle did not sound, and that the cab signal continued to display the "Approach-medium" aspect while the train was in the block of signal 118. The engineer testified that the cab signal immediately indicated "Restricting" when the locomotive passed signal 118 and that the cab-signal whistle did sound, that the cab signal soon afterward indicated "Approach" and later "Approach-medium", and that all three indications were called to the fireman and were, in turn, repeated by him. During the time that No. 68 was proceeding through the block of signal 118, there was no known change in any condition affecting the energization of either track circuit in the block.

The record shows that the roadway and cab signals functioned as intended for train No. 36 to signal 10R, for No. 68 to signal 118, and for all subsequent trains to signal 10R, and that tests made after the accident occurred show that the roadway signals and the cab-signal devices on the locomotive of No. 68 were then in proper operating condition. Considering these facts and the discrepancies between the testimony of the fireman and the engineer of No. 68, the record warrants the conclusion that the roadway and cab signals were functioning as intended when train No. 68 occupied the block between signals 118 and 10R.

The line on which this accident occurred is equipped with automatic block-signal and cab-signal systems. The cab signals continuously provide aspects in the cabs of equipped locomotives to indicate track conditions ahead to both the engineer and the fireman. However, a cab-signal system does not automatically enforce compliance with the speed restrictions imposed by restrictive signal indications. If the locomotive of No. 68 had been equipped with an automatic train-control device, functioning as intended, the speed of No. 68 would automatically have been restricted in the block of signal 118 to a predetermined low speed not exceeding 20 miles per hour and the evidence of record shows that the train would have been stopped before the collision occurred. The Pennsylvania Railroad Company has advised the Commission that the installation of speed-controlling devices is being progressed as rapidly as possible to comply with our recommendation contained in Accident at Woodbridge, N. J., _____ I.C.C., _____, (mimeograph decided April 19, 1951) that an automatic train-control system be installed on its New York Division.

Cause

It is found that this accident was caused by failure to operate the following train in accordance with signal indications.

Recommendation

We recommend that the Pennsylvania Railroad Company promptly include the line on which this accident occurred in the installation of the automatic train-control system now in progress on its New York Division, which system automatically and continuously will enforce a speed restriction of not exceeding 20 miles per hour while proceeding through a block occupied by a preceding or opposing train.

By the Commission, Division 3.

(SEAL)

W. P. BARTEL,
Secretary.