INTERSTATE COMMERCE COMMISSION

Ex Parte No. 200

ACCIDENTS AT SWAMPSCOTT AND REVERE, MASS.

Decided May 16, 1956.

Accidents at Swampscott and Revere, Mass., on February 28, 1956, caused by failure to operate the following trains in accordance with signal indications.

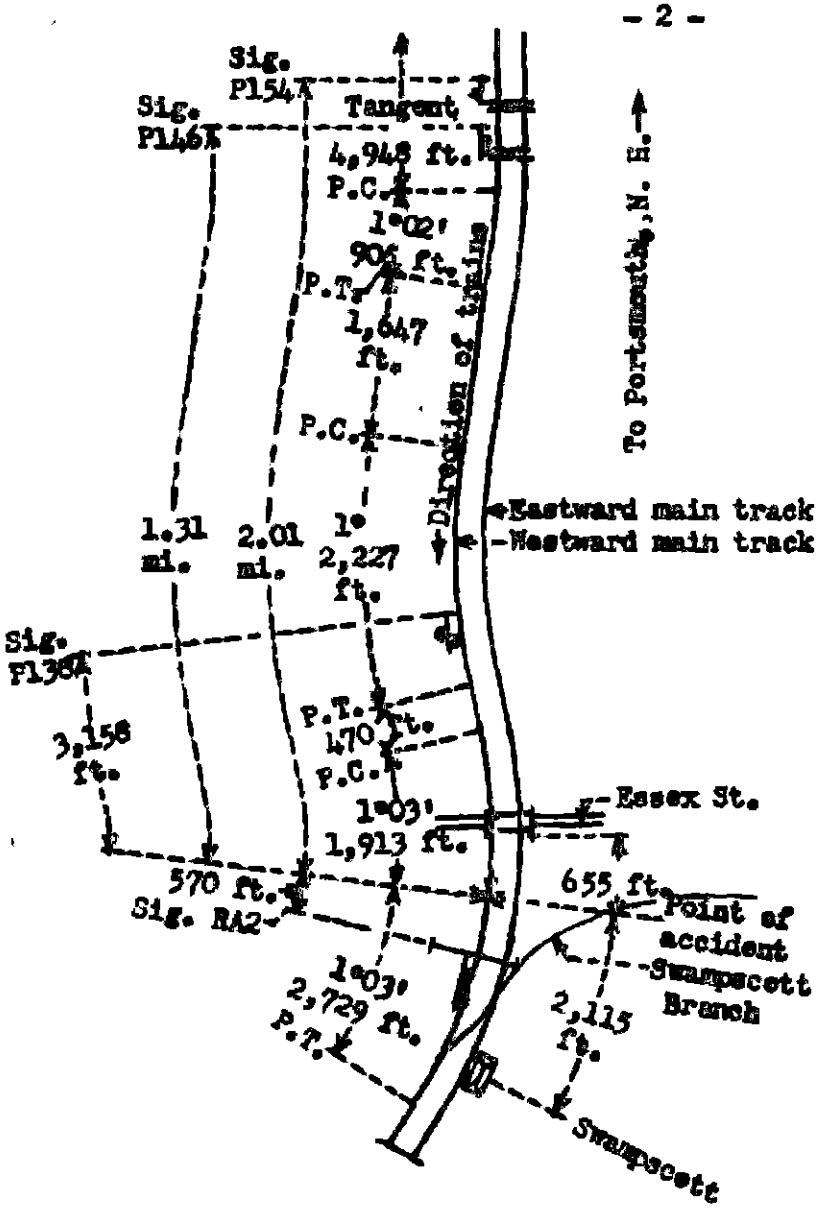
Richard Jackson for the Boston and Maine Railroad Company.
Edward N. Gadsby for the Massachusetts Department of Public Utilities.
Edward R. Thornton for the New Hampshire Public Utilities Commission.
Winslow E. Melvin for the New Hampshire Public Utilities Commission.
M. Paul Dugger for the Brotherhood of Locomotive Firemen and Enginemen.
J. L. Scanlon for the Brotherhood of Railroad Trainmen.
Richard C. Urie for Raymond F. Jones, Jr.
Frank A. Cashman for Raymond F. Jones, Sr.
John A. McNiff for Elenor Singerman, a passenger.
Ernest C. Hopkins for the Brotherhood of Locomotive Engineers.
Frederick N. Allen for the Maine Public Utilities Commission.

REPORT OF THE COMMISSION

DIVISION 3, COMMISSIONERS CLARKE, HUTCHINSON, AND MAHRATH

CLARKE, Commissioner:

This is an investigation by the Commission on its own motion with respect to the facts, conditions, and circumstances connected with two accidents which occurred on the Boston and Maine Railroad on February 28, 1956. The first accident occurred at Swampscott, Mass., and the second occurred at Revere, Mass. Joint hearing was had at Boston, Mass., on March 6, 7, and 9, 1956 with representatives of the Massachusetts Department of Public Utilities. Each accident was a rear-end collision between two passenger trains. The Swampscott accident resulted in the death of 11 passengers and 2 train-service employees, and the injury of 260 passengers and 10 train-service employees. The Revere accident resulted in the injury of 132 passengers and 11 train-service employees.



Eastern Route

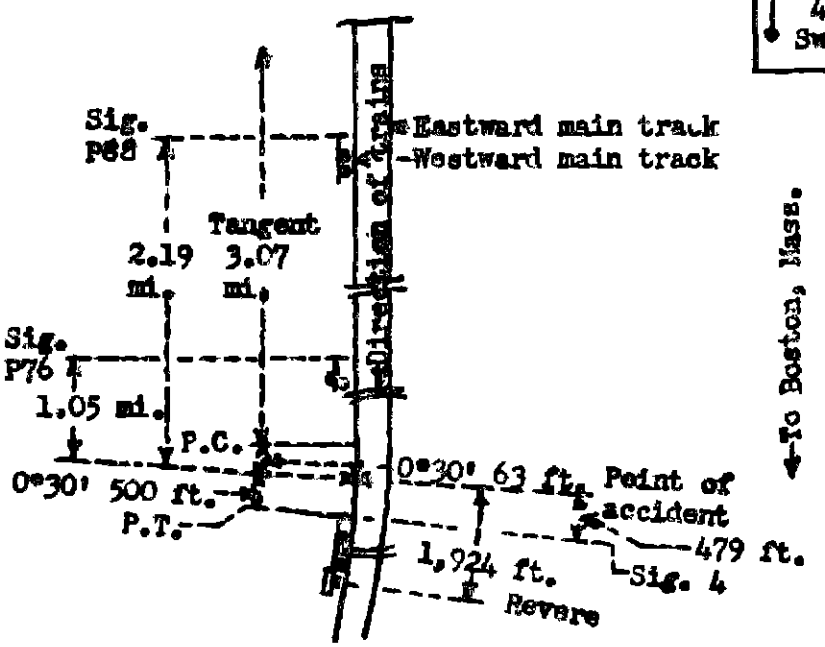
- Portsmouth, N. H.
  19.64 mi.
- Newburyport, Mass.
  18.94 mi.
- Beverly
  1.67 mi.
- Salem Tower
  0.34 mi.
- Salem
  3.52 mi.
- Swampscott
  (Point of First accident)
  0.99 mi.
- Lynn Tower
  5.58 mi.
- Revere
  (Point of Second accident)
  6.23 mi.
- Boston, Mass.

Danvers Branch

- Danvers, Mass.
  4.75 mi.
- Salem Tower, Mass.

Swampscott Branch

- Marblehead, Mass.
  4.41 mi.
- Swampscott, Mass.



Ex Parte No. 200
Boston and Maine Railroad
Swampscott and Revere, Mass.
February 28, 1956

Location of Accidents and Method of Operation

These accidents occurred on that part of the Portland and Terminal Divisions designated as the Eastern Route and extending between Portsmouth, N. H., and Boston, Mass., 56.91 miles. In the vicinity of the points of accident this is a double-track line, over which trains moving with the current of traffic are operated by timetable, train orders, and an automatic block-signal system. A line designated as the Danvers Branch extends from Danvers, Mass., to Salem Tower, a distance of 4.75 miles, and converges with the Eastern Route at Salem Tower, 40.25 miles west of Portsmouth. Another line, designated as the Swampscott Branch, extends from Marblehead, Mass., to Swampscott, a distance of 4.41 miles, and converges with the Eastern Route at Swampscott, 44.11 miles west of Portsmouth.

The Swampscott accident occurred on the westward main track of the Eastern Route at a point 2,115 feet east of the station at Swampscott. From the east there are, in succession, a tangent 4,948 feet in length, a 1°02' curve to the right 905 feet, a tangent 1,647 feet, a 1°00' curve to the left 2,227 feet, a tangent 470 feet, and a compound curve to the right, having a maximum curvature of 1°03', 1,913 feet to the point of accident and 2,729 feet westward. At the point of accident the curvature is 1°00'. Between points 1.70 miles and 1,000 feet east of the point of accident the grade averages 0.33 percent ascending westward. Between the latter point and the point of accident the grade is 0.33 percent descending westward.

As a west-bound train approaches the point of the Swampscott accident, the enginemen's view of the track ahead is considerably restricted by the side of a rock cut on the north side of the tracks, and by the north abutment of an overpass on which Essex Street crosses the tracks. The west end of the abutment, which is west of the rock cut, is 655 feet east of the point of accident.

The Revere accident occurred on the westward main track at a point 50.32 miles west of Portsmouth and 1,924 feet east of the location of the former station at Revere. From the east there is a tangent 3.07 miles in length and a 0°30' curve to the right 63 feet to the point of accident and 500 feet westward. From the east the grade is 0.47 percent ascending a distance of 1,400 feet, and practically level 500 feet to the point of accident.

Automatic signals P154, P146, and P138, and semi-automatic signal RA2 are located, respectively, 2.01 miles east, 1.31 miles east, 3,158 feet east, and 570 feet west of the point of the Swampscott accident. Automatic signals P88, P76, and 4 are located, respectively, 2.19 miles east, 1.05 miles east, and 479 feet west of the point of the Revere accident. Signal P154 is of the two-arm lower-quadrant semaphore type. The other signals are of the searchlight type and are approach lighted. Signal RA2 is an interlocking signal and is remotely controlled from Lynn Tower, 5,260 feet west of the station at Swampscott. The aspects of these signals applicable to this investigation and the corresponding indications and names are as follows:

Signal	Aspect	Indication	Name
P154	Both arms in diagonal position	PROCEED	CLEAR
P146) P88)	Green-over-green	PROCEED	CLEAR
	Yellow-over-red	PREPARE TO STOP AT NEXT SIGNAL. TRAIN EXCEEDING MEDIUM SPEED MUST AT ONCE REDUCE TO THAT SPEED	APPROACH
P138) P76)	Green-over-green, staggered	PROCEED	CLEAR
	Red-over-red, staggered	STOP, THEN PROCEED IN ACCORDANCE WITH RULES * * * D-509. * * *	STOP AND PROCEED
RA2) 4	Green-over-red-over-red	PROCEED	CLEAR
	Red-over-red-over-red	STOP	STOP

The controlling circuits are so arranged that when the blocks of signals P154 and P146 are clear and the block of signal P138 is occupied, signal P154 indicates Proceed, signal P146 indicates Prepare-to-stop-at-next-signal, and signal P138 indicates Stop-then-proceed-at-restricted-speed. When the block of signal P88 is clear and the block of signal P76 is occupied, signal P88 indicates Prepare-to-stop-at-next-signal, and signal P76 indicates Stop-then-proceed-at-restricted-speed.

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

DEFINITIONS

SPEEDS: Medium --A speed not exceeding 30 miles per hour.

Restricted --A speed that will permit stopping short of another train, obstruction, or switch not properly lined but not exceeding 15 miles per hour.

11. In block signal territory fusees burning red 5 minutes will be used. Train finding a lighted fusee will stop, then proceed at restricted speed to the next signal but for not less than one mile. * * *

* * *

27. * * * a signal imperfectly displayed, or the absence of a signal at a place where a signal is usually shown, must be regarded as the most restrictive indication that can be given by that signal, * * *

* * *

34. All members of train and engine crews must, when practicable, communicate to each other by its name the indication of each signal affecting the movement of their train or engine.

Indications must not be called until seen by the person calling. (This does not prohibit enginemen acknowledging by name, signal called, which he cannot see.) * * *

99. When a train is moving under circumstances in which it may be overtaken by another train, the flagman must throw off lighted fusees at proper intervals and take such other action as may be necessary to insure full protection.

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, protection against following trains on the same track will have been provided when full protection is afforded against trains moving at restricted speed.

* * *

D-509. When a train or engine is stopped by an automatic block signal it may proceed at once at restricted speed. * * *

The maximum authorized speed for passenger trains on the line on which these accidents occurred is 60 miles per hour.

Description of Swampscott Accident

No. 214, a west-bound first-class passenger train en route from Portsmouth to Boston, consisted of Diesel-electric unit 1516, a road-switcher type, five coaches, and one combination baggage-smoking car, in the order named. All cars were of all-steel construction. This train departed from Portsmouth at 6:40 a. m., on time, and departed from Salem Tower, the last reporting station, at 8:10 a. m. The speed of the train was reduced at signal P146 because the aspect of the signal was obscured by snow and the enginemen were unable to determine the indication until the locomotive was closely approaching. The roundels of signals P138 and RA2 were covered with snow to the extent that the enginemen could not distinguish a light in either signal. The train passed signal P138 at low speed and was stopped at signal RA2. Between 2 and 3 minutes later the rear end was struck by No. 2406. The accident occurred at a point 2,115 feet east of the station at Swampscott. No. 214 was due to leave Swampscott at 7:54 a. m., approximately 24 minutes before the accident occurred.

No. 2406, a west-bound first-class passenger train en route from Danvers to Boston, consisted of three Diesel-powered passenger units and one Diesel-powered passenger-baggage unit, in the order named. This train was held at Salem Tower to follow No. 214. After No. 214 passed, No. 2406 passed Salem Tower and entered the Eastern Route at 8:12 a. m. It passed signal P146, which should have indicated Prepare-to-stop-at-next-signal, passed signal P138, which should have indicated Stop-then-proceed-at-restricted-speed, and while moving at a speed estimated to have been between 40 and 55 miles per hour it struck the rear end of No. 214. No. 2406 was due to leave Swampscott at 8:08 a. m., approximately 10 minutes before the accident occurred.

No. 214 was moved westward a distance of approximately 50 feet by the force of the impact. When the impact occurred, the underframe of the rear car of No. 214 overrode the underframe of the first unit of No. 2406. Both trucks of the rear car of No. 214 were displaced, and the underframe of this car sheared the superstructure from the first unit of No. 2406. The rear end of the rear car of No. 214 was deflected to the north, and the car stopped upright, at an angle of approximately 45 degrees to the tracks, with the rear end toward the northeast. The front end of the car was resting on top of the rear end of the first unit of No. 2406. The draft sills at the rear end were somewhat distorted, and the car was considerably damaged. The rear end of the fifth car was derailed to the south, and this car stopped upright with the rear end between the two main tracks. It was somewhat damaged. The first, second, and fourth cars were slightly damaged.

No. 2406 stopped with the front end of the first unit approximately 200 feet west of the point of collision. The first unit was derailed to the north and stopped against the side of the fifth car of No. 214. The superstructure was sheared off the underframe from the front end of the unit to within a few feet from the rear end. The front end underframe assembly was deflected downward, and the center sills were broken behind the front bolster. The other units, which were also derailed, stopped upright and in line with the track. The front end of the second unit was badly damaged, and the third and fourth units were somewhat damaged.

The engineer and the fireman of No. 2406 were killed. The engineer, the fireman, the conductor, two assistant conductors, and the flagman of No. 214, and the conductor, the assistant conductor, the train baggageman, and the flagman of No. 2406 were injured.

A heavy wet snow was falling at the time of the accident, which occurred about 8:18 a. m. The U. S. Weather Bureau station at the airport at East Boston, Mass., approximately 12 miles southwest of Swampscott, reported that between 8 a. m. and 9 a. m. the temperature was 29 degrees above zero.

Diesel-powered passenger units of the type involved are of stainless steel construction. Each is 85 feet long between pulling faces of the couplers and is mounted on two four-wheel trucks. The weight in working order is 118,500 pounds. Power is supplied by two 275-horsepower Diesel engines mounted under the floor of the unit. Each engine drives the inboard axle of one truck through a torque converter transmission. An operator's station is located at the right hand side of the vestibule at each end of the unit. A representative of the

builder of these units testified that the construction of the units met or exceeded the minimum strength requirements contained in the specifications for the construction of new passenger equipment cars adopted as standard by the Association of American Railroads. Among these specifications are the following: A car structure is required which will resist minimum static end load of 800,000 pounds applied on center line of draft without developing any permanent deformation in any member of the car structure; the outside ends of each car shall be provided with two main vertical members, one at each side of the diaphragm opening; each of these members shall have a section modulus of not less than 24.375, and the sum of the section moduli of all vertical end members at each end of the car shall be not less than 66; the two main vertical end members are required to have an ultimate shear value of not less than 300,000 pounds each at a point even with the top of the underframe to which they are attached.

The brakes of these units are of the disc type. The brake equipment includes a control valve of the D-22-AR type and an M23 brake valve at each control station. A safety-control feature actuated by a pedal is provided. If pressure on this pedal is released an emergency application of the brakes will result, unless a brake application of a predetermined brake-cylinder pressure has been made. Each control compartment is equipped with a push button for manual control of the sanding devices. Sand delivery hose and traps and delivery nozzles are provided. These are so located that, when the unit is moving in either direction and the sanding devices are actuated, sand is deposited on the rails in front of the front wheels of each truck. The rate of flow of sand is regulated by pre-adjustment of air-pressure nozzles located in the traps. A brake disc is bolted to the inner face of the hub of each wheel, and braking force is applied by pressure of composition-lined brake shoes against the faces of this disc. An anti-wheel-slide device of the electro-pneumatic type is provided. This consists of inertia devices applied to a journal box of each axle and connected in such manner that an excessive rate of deceleration of any pair of wheels closes electrical contacts which actuate an electric solenoid valve in the control box to release air from the brake cylinder, and, under control of a time relay, reopen the circuit to reapply air to the brake cylinder after a predetermined time interval. During service application of the brakes, each operation of the anti-wheel-slide device will actuate the sanding apparatus for a 3-second interval and will cause sand to be deposited on the rails in front of the front wheels of the truck. Automatic sanding of the rails during an emergency application of the brakes is provided and functions for a period of 30 seconds during such applications. A hand brake is located in the vestibule at one end of each unit.

Discussion of Swampscott Accident

After No. 214 departed from Newburyport, Mass., 19.64 miles west of Portsmouth, a defective condition of the supercharger of the Diesel engine developed and the train lost running time. Snow was falling, and a strong wind was blowing from the north and northeast. When the train reached Beverly, 38.58 miles west of Portsmouth, the enginemen found that the roundels of the signal of an interlocking were covered with snow to the extent that they could not determine the indication of the signal, and it was necessary to stop and obtain permission from the operator to proceed. After the train departed from the station at Salem, 40.59 miles west of Portsmouth, blowing snow restricted the enginemen's range of vision to a distance of from 1,000 to 1,500 feet. The enginemen saw the aspect of semaphore signal P154, which indicated Proceed. Because of snow on the roundels of signal P146, the enginemen were unable to see a light in the signal as the train approached. The engineer reduced the speed to about 5 miles per hour, and as the locomotive was about to reach the signal he saw that the signal was displaying a faint green light. The enginemen were unable to distinguish a light in signal P138 as the locomotive approached and passed the signal. Because of the defective condition of the supercharger the engineer did not want to stop the train if it could be avoided, and he passed the signal at a speed of 2 or 3 miles per hour and proceeded at restricted speed to signal RA2. No lights were visible in this signal, and the train was stopped at the signal. After the train stopped, the engineer applied the independent brake and released the automatic brake. The conductor alighted from the first car and called the operator at Lynn Tower on the telephone to secure permission for the train to pass the signal. The engineer saw No. 2406 as that train passed under the overpass at Essex Street, and at approximately the same time he heard the pneumatic horn of that train sounded. Both the engineer and the conductor estimated that the collision occurred between 2 and 3 minutes after the train stopped. Before the train arrived at signal RA2 the flagman had dropped a lighted 5-minute red fusee in the vicinity of signal P146 and a second fusee in the vicinity of signal P138. He did not know whether either of them remained lighted. When the train stopped at signal RA2 the flagman immediately proceeded eastward to provide protection. When he reached a point about 175 feet east of the rear end of his train he heard the sound of an approaching train. He then began to run eastward. Because of curvature of the track he was unable to see No. 2406 until that train was closely approaching the overpass at Essex Street. When he saw the train he gave stop signals with a red flag, but he did not have time to light a fusee before the train passed. The engineer of No. 2406 sounded a whistle signal immediately after he reached a point from which the flagman's signals

could be seen by him. The flagman saw that both the engineer and the firemen were standing when the front of the train passed. He was not certain of his exact location, but he thought he was about 200 feet east of the rear end of his train when the collision occurred. He estimated that No. 2406 passed him at a speed of 50 or 55 miles per hour. Because the units of No. 2406 were equipped with disc brakes, the flagman was unable to determine whether the brakes were applied as the train approached and passed him.

When the accident occurred, the crew of No. 2406 was returning to Boston after having made an east-bound trip from Boston to Danvers. The brakes of the train had been tested before departure from Boston, the initial terminal, and also before departure from Danvers. The train made three station stops between Danvers and Salem Tower, and was then held at Salem Tower about 14 minutes to follow No. 214. After No. 214 passed, No. 2406 entered the Eastern Route and stopped at the station at Salem. The brakes apparently functioned properly when making each of these stops. The conductor had talked with the enginemen several times during the morning, and he thought they were in normal mental and physical condition. As the train was leaving Salem the engineer remarked to the conductor that No. 214 was close ahead. The conductor estimated that at this time visibility was restricted by blowing snow to a distance of about 200 feet. As No. 2406 was approaching Swampscott the conductor was in the first unit, and the assistant conductor and the train baggageman were in the rear unit. None of these employees had noticed a brake application or a reduction in speed after the train departed from Salem. The conductor estimated that the speed was between 40 and 45 miles per hour as the train approached Swampscott, and the other two employees estimated that it was between 45 and 50 miles per hour. The conductor, who was near the front end of the first unit was not aware that anything was wrong until he saw that the enginemen had opened the door and were entering the passenger compartment. The engineer warned him that there would be a collision, and the accident occurred almost immediately afterward. The conductor had not noticed the sound of the pneumatic horn. Each of the three members of the train crew who were questioned testified that he felt no brake application before the collision occurred. Both the conductor and the assistant conductor were standing in the aisle, and each of these employees thought he would have noticed an effective brake application.

In observations made after the accident occurred, it was found that the view of the point of accident from the engineer's position at the front of a Diesel-powered passenger unit approaching from the east is restricted by the north abutment of the overpass at Essex Street to a distance of 747 feet.

No. 2506, the train which followed No. 2406, passed Salem Tower at 8:20 a. m. This train consisted of a Diesel-electric locomotive and six cars. The engineer testified that signal P154 indicated Proceed and that as the train approached signal P146 he asked the fireman, who was operating the locomotive, whether he could determine the indication of the signal. The fireman called the signal as indicating Proceed. As the train was passing the signal the fireman made a brake application and informed the engineer that he was uncertain as to the indication of the signal. This train was stopped at signal P138 in response to signals given by the flagman of No. 2406. The enginemen were unable to distinguish a light in this signal either before or after the train stopped.

The equipment of No. 2406 was examined at the scene of the accident by an inspector of this Commission approximately 2 hours 20 minutes after the accident occurred. In the wreckage of the control compartment the handle of the automatic brake valve was found to be in emergency position. All brakes which could be examined at this time were found in release position. Later this equipment was removed to the shops of the carrier, and the brake equipment of the rear three units was tested. After breaks in the piping were plugged the brake system was charged from a shop air line, and the brakes functioned properly. The sanders were not tested at this time. The equipment had received severe shocks at the time of the accident and during subsequent rerailing operations, and it was considered that tests would not indicate the condition of the sanders before the accident occurred. No flat spots were found on the wheels of any of the units. The automatic brake valve and the service and emergency portions of the control valve of the first unit were tested on a test rack in accordance with standard tests, and they met all requirements of these tests. Examination of the inspection and repair reports for these units for a period of approximately 1 month prior to the occurrence of the accident disclosed that on February 15 the anti-wheel-slide device of the second unit was reported to function at times with brake-pipe reductions of 10 pounds. No other items pertinent to this accident were reported.

Description of Revere Accident

No. 2206, a west-bound first-class passenger train en route from Marblehead to Boston, consisted of Diesel-electric unit 1573, a road-switcher type, four coaches, and one combination baggage-smoking car, in the order named. All cars were of all-steel construction. This train departed from Marblehead at 7:57 a. m., on time, and passed Lynn Tower, the last reporting station, at 9:11 a. m. It was stopped at signal 4 because the roundels of the signal were covered

with snow to the extent that the enginemen were unable to determine the indication. About 2 minutes later the rear end of the train was struck by No. 2208. The accident occurred at a point 1,924 feet east of the location of the former station at Revere. No. 2206 was due to leave Revere at 8:26 a. m., 1 hour 3 minutes before the accident occurred.

No. 2208, a west-bound first-class passenger train en route from Marblehead to Boston, consisted of two Diesel-powered passenger units. The units were of the same type as the units of No. 2406. This train departed from Marblehead at 8:30 a. m., on time, and passed Lynn Tower at 9:21 a. m. It passed signal P88, which should have indicated Prepare-to-stop-at-next-signal, passed signal P76, which should have indicated Stop-then-proceed-at-restricted-speed, and while moving at a speed variously estimated as from 5 to 30 miles per hour it struck the rear end of No. 2206. No. 2208 was due to leave Revere at 8:53 a. m., 36 minutes before the accident occurred.

No equipment of either train was derailed. The rear end of the rear car of No. 2206 and the front end of the first unit of No. 2208 were slightly damaged. Several windows in the cars of No. 2206 were broken, and many seat pedestals in these cars were loosened from the floor by the force of the impact. The mounting brackets of one engine of the first unit and both engines of the second unit of No. 2208 were bent, and both units were somewhat damaged.

The engineer, the fireman, the conductor, an assistant conductor, the train baggageman, and the flagman of No. 2206, and the engineer, the fireman, the conductor, an assistant conductor, and the flagman of No. 2208 were injured.

A heavy snow was falling at the time of the accident, which occurred at 9:29 a. m. The U. S. Weather Bureau Station at the airport at East Boston reported that between 9 a. m. and 10 a. m. the temperature was 26 degrees above zero.

Discussion of Revere Accident

No. 2206 arrived at Swampscott about 8:12 a. m. and was held at that point for a considerable period of time because of the collision between No. 214 and No. 2406. It was then operated over the eastward main track from Swampscott to Lynn Tower and entered the westward main track at the latter point. A heavy wet snow was falling, and the enginemen's range of vision was restricted to a distance which the engineer estimated as from 400 to 600 feet. Between Lynn Tower and signal P88 there are two automatic signals and two interlocking signals governing west-bound movements on the westward main track. The roundels of the signals were covered with snow, and the

train was stopped at the first automatic signal because the enginemen were unable to determine the indication. After the train stopped, the enginemen saw that the signal indicated Proceed. It was necessary to stop the train at each of the interlocking signals and to clean the snow from the roundels before the enginemen could determine the indications. The aspects of signals P88 and P76 each were somewhat obscured, but the enginemen were able to determine the aspect of each signal, which indicated Proceed. The train passed each signal at a speed of about 15 miles per hour. The enginemen were unable to determine the indication of signal 4, and the train was stopped at the signal. When the train stopped, the engineer applied the independent brake and released the automatic brake. About 2 minutes after the train stopped, and while the fireman was cleaning the snow from the signal, the rear end of the train was struck by No. 2208. The fireman said that the roundel of each signal which he cleaned was covered with an inch or more of heavy wet snow and that there was a light coating of ice over the snow on signal 4. Before the train reached Revere the flagman had left a lighted 5-minute red fusee at each of the two interlocking signals west of Lynn Tower, and had dropped a fusee as the train approached signal P76 and a second fusee as the train passed the signal. He did not know whether the latter two fusees remained lighted. Before No. 2206 stopped at Revere the flagman saw the headlight of the following train. As soon as the speed of No. 2206 was reduced sufficiently to permit him to alight, he proceeded eastward and gave stop signals with a lighted fusee. He thought he had reached a point between 100 and 150 feet east of the rear end of his train when No. 2208 passed. He estimated that the speed of No. 2208 was between 10 and 15 miles per hour as that train passed. An assistant conductor who was at the rear of the rear car of No. 2206 estimated that the flagman had reached a point between 120 and 200 feet east of the rear end of his train when No. 2208 passed.

When the accident occurred the crew of No. 2208 was returning from Marblehead to Boston after having completed one round trip between these points. The same equipment was used on each trip. The brakes had been tested before departure from Boston, the initial terminal, and also after the enginemen changed control compartments at each turnaround point. They had functioned properly during these tests and when used en route. No. 2208 arrived at Swampscott about 8:47 a. m., and was stopped at that point in response to stop signals given by the flagman of No. 2206. After No. 2206 departed, No. 2208 was routed over the eastward main track from Swampscott to Lynn Tower and entered the westward main track at the latter point. Visibility was materially restricted by blowing snow, and the engineer estimated that his range of vision was about 200 feet at

some points and 600 or 700 feet at other points. Until the train reached signal P88 the aspect of each signal was clearly visible and each signal indicated Proceed. The aspect of signal P88 was somewhat obscured, and the engineer prepared to stop short of the signal. When he reached a point about 100 feet east of the signal he saw that the aspect appeared to indicate Proceed. The aspect of signal P76 was somewhat obscured also. The engineer reduced the speed to about 15 miles per hour, and as the train closely approached the signal the enginemen saw that the aspect of this signal appeared to indicate Proceed. The engineer saw the rear end of No. 2206 at a distance which he thought was 750 or 800 feet. At this time the speed of the train was 33 miles per hour. The engineer immediately made a service application of the brakes. The brake application did not appear to be effective, and the engineer observed that the gauge indicated that the brake-cylinder pressure was 40 pounds and that the anti-wheel-slide device on the front truck was actuated several times. Actuation of the anti-wheel-slide devices on other trucks is not indicated on the gauge in the front control compartment. The engineer then took his foot off the safety-control pedal and moved the brake valve to emergency position. When he saw that the train would not stop short of the preceding train he stepped to the door and warned the passengers in the first unit. He thought that the speed had been reduced to 5 or 6 miles per hour when the collision occurred. He estimated that if the rails had been dry and the anti-wheel-slide devices had not been actuated he could have stopped within half the distance at which he first saw the preceding train. The assistant conductor estimated that the speed was about 30 miles per hour as the train approached the point of accident. He was not aware of a brake application before the collision occurred. The flagman thought the speed was 25 or 30 miles per hour. Both the conductor and the flagman thought the speed was reduced before the collision occurred. The enginemen both saw the flagman of the preceding train with a lighted fusee, but they thought he was only a few feet east of the rear end of his train. They had not seen any other lighted fusees after leaving Swampscott.

The air-brake equipment of No. 2206 was tested at Boston about 3:30 p. m. on the day of the accident and, with the exception of the sanding devices, was found to function properly. When the sanders on the first unit were tested it was found that sand flowed from both nozzles on the front truck but from only one nozzle on the rear truck. The units had been separated before the tests were made. At the time of the tests it was not determined which end of the second unit was ahead at the time of the accident, and the sanders

of this unit were tested from both ends. When tested from the A end of the unit, sand flowed from the two nozzles on one side of the unit, but none flowed from either nozzle on the other side. When tested from the opposite end of the unit, no sand flowed from any of the nozzles. When the unit was inspected later it was found that both engines were shifted toward the A end, indicating that this end was ahead at the time of the accident.

Discussion of Both Accidents

The signal apparatus in the vicinity of the point of each accident was inspected and tested by the signal force of the carrier after the accidents occurred. No condition was found which could have caused an improper operation of the signals involved in either accident. However, at the time of the accidents the roundels of the signals involved were covered with snow. In the investigation of the Swampscott accident, the engineer of the train which preceded No. 2406 testified that it was difficult to determine the indication of signal P146. The engineer of the train which followed No. 2406 testified that his fireman, who was operating the locomotive, was uncertain of the indication of this signal. Both of these engineers testified that it was impossible to determine the indication of signal P139. In the investigation of the Revere accident, the enginemen of the train which preceded No. 2208 testified that they experienced difficulty in determining the indications of signals P88 and P76. The enginemen of No. 2208 testified that they thought that signals P88 and P76 each indicated Proceed.

According to the testimony of the engineer of No. 2208 the Revere accident would have been averted if the brake application which he made when he first saw the rear end of the preceding train had been effective. This witness testified that with the exception of the stop at Revere he had experienced no difficulty in controlling the speed of the train on the day of the accident. However, he also testified that on previous occasions when rail conditions had been unfavorable he had experienced difficulty in making station stops with this type of equipment, and that it was not uncommon for enginemen to overrun stations while operating this type of equipment under these conditions. Another engineer who was questioned during the hearing testified that the brakes on this type of equipment are very satisfactory when rail conditions are favorable, but when rail conditions are unfavorable it is necessary to anticipate a considerable increase in stopping distances. He testified that on one occasion, under unfavorable rail conditions, he had overrun a station a distance of 1,200 or 1,500 feet. In this instance he had approached the station at a speed of 40 or 45 miles

per hour. He had anticipated as he approached the station that the stopping distance might be increased by action of the anti-wheel-slide devices, but after making allowances for this possibility he had passed the station at a speed of 25 or 30 miles per hour.

According to the testimony of a representative of the manufacturer of the equipment, the brake was designed to produce maximum braking effort consistent with wheel-rail adhesion under normal rail conditions. The anti-wheel-slide device is employed to prevent wheels from sliding when this adhesion is reduced because of unfavorable rail conditions. As this witness described the operation of the device, when a wheel begins to slip or slide brake-cylinder pressure on that truck is reduced momentarily to permit the wheel to regain rail speed. The brake is then reapplied. Approximately 3 seconds elapse between the time the device is actuated and the time brake-cylinder pressure is fully restored, and during this period sand is automatically deposited on the rails to restore wheel-rail adhesion. On a two-unit train, each time an anti-wheel-slide device is actuated the stopping distance is increased approximately 6 feet for each 5 miles per hour the train is moving, but since sliding adhesion is less than rolling adhesion the stopping distance is not increased to the extent it would be if the wheel were allowed to continue to slide. The anti-wheel-slide device on each truck functions independently of the devices on the other trucks of a train. Each of the four sanding stations on each unit functions independently, and the failure of one would not affect the others. Wheel-rail adhesion is restored immediately by automatic sanding each time an anti-wheel-slide device functions, and it was the opinion of this witness that for this reason it is not likely that there would be a series of wheel slips which would actuate the device repeatedly.

On March 30, 1956, tests were conducted to determine stopping distances for a train consisting of four Diesel-powered passenger units similar to those involved in the Swampscott accident. These tests were conducted on the southward main track between Woburn Junction and Winchester, Mass. At the point at which the tests were made the track is tangent. The grade is 0.18 percent descending southward, the direction in which the test train was operated. The weather was cloudy, and there was an intermittent drizzle. The temperature was between 35 and 40 degrees above zero. There was no appreciable wind velocity. The ground was covered with wet heavy snow. This snow was not disturbed by air currents resulting from passage of the test train and was not of sufficient depth to cover the rails. In general the rails were wet as a result of the weather conditions, and during each of the first three tests additional

water was applied to the rails by means of sprays mounted in front of the front truck of the first unit of the train. The same section of track was used in making each test.

In the first test a full service application of the brakes was made while the train was moving at a speed of 48 miles per hour. The train stopped in 27 seconds and within a distance of 1,209 feet. The calculated stopping distance was 1,250 feet. In the second test an emergency brake application was made at a speed of 48 miles per hour. The train stopped in 20.5 seconds and within a distance of 806 feet. The calculated stopping distance was 800 feet. In the third test an emergency brake application was initiated by the pedal of the safety-control feature at a speed of 48 miles per hour. The train stopped in 21 seconds and within a distance of 823 feet. During the fourth test water was not sprayed on the rails in front of the train. An emergency brake application was made at a speed of 70 miles per hour. The train stopped in 28.6 seconds and within a distance of 1,530 feet. The calculated stopping distance was 1,540 feet. The service application of the brakes developed brake-cylinder pressure of 60 pounds, and the emergency applications each developed brake-cylinder pressure of 78 pounds. The feed valve was adjusted to supply brake-pipe pressure of 90 pounds. The anti-wheel-slide devices were not actuated except during the first test. During this test the device on each truck of the rear unit was actuated once.

During these tests the brakes of the train were effective and functioned as intended. However, while these tests indicated that the rates of deceleration were satisfactory under the conditions which existed at the time of the tests, they are not conclusive as to the possible results of tests made under other conditions. During the investigation of these accidents two engineers testified that they had experienced difficulty in controlling the speed of this type of equipment under certain conditions. This Commission has also received reports, both before and after the investigation of these accidents, that engineers on other railroads have experienced similar difficulty. From these reports it appears that some difficulty has been experienced which may have been the result of the functioning of anti-wheel-slide devices, and that other difficulty has been experienced which may have been the result of ice and snow on brake discs and shoes. When the tests were conducted on March 30 the sanders of the test train functioned properly, as indicated by sand on the rails behind the train after the first emergency stop, and with two exceptions the anti-wheel-slide devices were not actuated. At the time of the tests the temperature was above freezing, and there was no accumulation of snow or ice on the brake discs, brake shoes, or trucks.

The air-brake systems of these units have been designed to produce a high rate of deceleration, and it is necessary to have a high level of wheel-rail adhesion to prevent the operation of the anti-wheel-slide devices. The anti-wheel-slide device of a pair of wheels operates when the adhesion drops to a point at which the wheels begin to slip or slide. Sanding of the rails is then necessary in order to obtain a high level of adhesion to restore the wheels to normal rotation. It has been observed in the operation of these units under unfavorable rail conditions that if the sanding devices of a unit fail to deliver sand when required, or fail to deliver sufficient sand, the deceleration of the unit may be impaired by repeated operation of the anti-wheel-slide devices.

It has been reported to the Commission that instances of failure to control speed properly have occurred when snow was blowing and the temperature was a few degrees below freezing. From these reports it appears that under these weather conditions wet snow and moisture froze on the brake discs and shoes while the brakes were released, and that when the brakes were then applied they did not become effective until the ice was cleared from the faces of the discs and the friction surfaces of the shoes.

It would appear that the management of the Boston and Maine Railroad is aware that this type of brake equipment is affected by weather conditions and also that a brake application when rail conditions are unfavorable may result in actuation of the anti-wheel-slide devices, as indicated by the instructions which have been issued for handling this type of equipment. These instructions read in part as follows:

> During snow and icy conditions when braking discs and shoe linings may be wet, it is important that braking for slow downs and stops be started sooner than usual. The initial brake pipe reduction should be sufficient to develop high B.C. pressure (consistent with speed) to clean the discs and brake linings as quickly as possible. Manual sanding must be used if rail conditions are such that Rolokrons may operate. Brake cylinder pressure should be graduated off as required.
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> When bad rail conditions exist (rain, leaves, frost, etc.) it is important that brake applications for stops or slow-downs be started in sufficient time so that two or more brake applications can be made, if necessary, to insure proper control of speed. Manual sanding must be used as required, to prevent any unnecessary Rolokron operation.
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This Commission has investigated one previous accident in which failure to control the speed of a Diesel-powered passenger unit of similar type was involved. At the time of this accident the weather was clear and the rails were dry. The engineer said that he made an emergency application of the brakes while moving at a speed which he estimated as 30 miles per hour. The train then moved a distance of approximately 875 feet and struck the rear end of a preceding train. After the accident occurred the rails were found to be sanded throughout this distance. Both the engineer and the conductor said that the anti-wheel-slide devices were actuated after the brakes were applied.

In the Swampscott accident, it is improbable that the following train could have been stopped short of the point of accident after it reached a point from which the engineer could see the flagman of the preceding train, in view of the excessive rate of speed, but there should have been a considerable reduction in speed within this distance if an effective brake application had been obtained. The engineer sounded the pneumatic horn and left his seat before he passed the flagman of No. 214. While there is no evidence that he made a brake application before leaving his seat, it is obvious that he removed his foot from the safety-control pedal after he left his seat. In the Revere accident, the engineer of the following train testified that the stopping distance of his train was considerably extended by action of the anti-wheel-slide devices. In view of the questions which have been raised concerning the variations in the rate of deceleration of this type of equipment under various conditions, it appears that a series of tests is warranted which will be sufficiently comprehensive to determine the operational characteristics of this type of brake under all climatic and rail conditions. This type of brake is in use throughout the country, and it would be desirable that such tests be conducted under conditions which will determine the operational characteristics not only under the conditions which exist on the Boston and Maine Railroad but also under conditions which exist on other railroads.

We find that:

1. The signal apparatus involved in each accident was operating properly at the time of the accidents.

2. The roundels of the signals were covered with snow, thereby obscuring the signal aspects to such an extent that, in accordance with the carrier's operating rules, the trains were not authorized to proceed in excess of restricted speed, which is not to exceed 15 miles per hour.

3. Each accident was caused by failure to operate the following train in accordance with signal indications.

4. In each accident the following train was being operated at an excessive rate of speed.

5. At Swampscott the engineer of No. 2406 sounded the pneumatic horn and left his seat before he passed the flagman of No. 214, but there was no appreciable deceleration of the train before the accident occurred.

6. At Revere the engineer of No. 2208 applied the brakes as the train approached the point of impact, but the stopping distance may have been extended as a result of functioning of the anti-wheel-slide devices.

7. The efficiency and reliability of the type of brake equipment in use on the Diesel-powered passenger units involved in these accidents has proved satisfactory under normal operating conditions in various classes of service over a considerable period of time. In the braking tests conducted on March 30, 1956, the rate of deceleration obtained in both service and emergency brake applications was very satisfactory.

8. The tests conducted on March 30, 1956, are not conclusive as to the retardation which might be obtained under certain adverse conditions which occasionally occur and which have been reported to affect the rate of deceleration.

Recommendation

We recommend that the Association of American Railroads conduct a series of tests which will be sufficiently comprehensive to determine the operational characteristics under adverse conditions of the type of brake in use on the Diesel-powered passenger units involved in these accidents.

By the Commission, Division 3.

(SEAL)

HAROLD D. McCOY,

Secretary.