INTERSTATE COMMERCE COMMISSION

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REPORT OF THE CHIEF OF THE DIVISION OF SAFETY COVERING THE INVESTIGATION OF AN ACCIDENT WHICH OCCURRED ON THE NEW YORK, NEW HAVEN & HARTFORD RAILROAD NEAR MILFORD, CONN., FEBRUARY 22, 1916.

March 14, 1916.

To the Commission:

On February 22, 1916, there was a rear-end collision between two passenger trains, also involving a freight train on an adjoining track, on the New York, New Haven & Hartford Railroad near Milford, Conn., which resulted in the death of 3 passengers, 3 employees on duty, 2 employees off duty, 1 Pullman employee, 1 person riding on the engine without authority, and injury to 235 passengers, 9 employees on duty, 15 employees off duty, 4 Pullman employees and 3 persons carried under contract. A public hearing was held in New Haven, Conn., on February 24 - 25, 1916, and the Public Utilities Commission of the State of Connecticut, which was then engaged in an investigation on its own initiative, was invited to and did participate in this hearing. As a result of the investigation of this accident I beg to submit the following report:

The accident occurred on the New York Division of the New York, New Haven & Hartford Railroad at a point about 2 miles east of Milford, Conn. The line at this point is four-tracked and the general direction is east and west. The tracks numbered from north to south are 3, 1, 2 and 4, tracks 3 and 1 being used by westbound trains, while tracks 2 and 4 are used by eastbound trains. The movement of trains is governed by time table and an automatic block signal system. Trains on this Division may be propelled by steam or electric locomotives, current for the latter being supplied from wires suspended over each track from catenary bridges located 300 feet apart and extending across all four tracks.

Beginning at Signal Tower 73, located about 6 miles west of New Haven and proceeding westward, the track is tangent for 4,521 feet, and following is a 50-minute curve to the right 686 feet in length; the track is then tangent for 2,600 feet. Located 640 feet west of tower 73 is automatic signal 65.93, on bridge 960, and 4,814 feet farther west is automatic

signal 65.23 on bridge 944.

All four tracks are automatically signalled between New Haven and Stamford and those in the vicinity of the accident were put in service on June 3, 1914. The length of blocks is not uniform, but signal locations were established to provide proper spacing of trains, giving proper consideration to grades, visibility, curvature and interlocking plants. The average length of blocks is about one mile.

The signals are suspended from the catenary bridges which support the electric propulsion power wires, being hung to the right of the track they govern. Each signal has two arms-a home and a distant,- the home being above the distant arm. The end of the home arm is pointed and that of the distant arm is "fish-tailed," the former being red and the latter yellow. The indication for each automatic signal is a red light over yellow, or both arms horizontal for stop; green over yellow or top arm inclined with lower arm horizontal, prepare to stop at next signal; both lights green and both arms inclined, proceed.

Power for the signal system is furnished from separate generators in Cos Cob power house and is transmitted on independent feeders at 2300 volts, single phase, 60 cycles. Step-down transformers are provided to reduce the voltage to 110 volts for signal operation. Additional transformers further reduce this to 12 volts for signal lighting, and to the necessary voltage for track circuits. A current of 60 cycles is used for signal operation, as the propulsion current is 25-cycle.

The signals are of the General Railway Signal Company's 2-A type, with A. C. induction motors. There is a separate mechanism on the deck of the bridge for each home and distant arm, and up-and-down rods inside of the supporting pipe connect the mechanisms with the spindle upon which the arm is mounted.

The track circuits are not usually over 4,000 feet long, and in many cases they are shorter. Between signals 65.93 and 65.23, which were concerned in the accident, there are two track sections, each 2,400 feet long. The current supplied through the transformers to the track circuit varies in voltage and quantity according to the length of each track section, as well as other physical conditions. Impedance bonds are installed at the end of each section, which offer a minimum resistance to the 25-cycle propulsion current but check the 60-cycle signal current.

The track circuit relays are of the centrifugal frequency type. The main operating part of these relays consist of a small induction motor, so designed that it will only revolve at full speed when 60-cycle current is provided. The relays are "two element," that is, 110 volts from the line transformer is constantly supplied to the stator, or field coils, and the rotor receives current from the track circuit. The relay motor will not operate at full speed unless both these currents are of the same phase and frequency. When the track is unoccupied the relay motor is continuously in operation.

The contacts are made by governor balls which fly out when the motor is operating at full speed and close the contacts through a proper system of levers. Counterweights open the contacts when the speed of the motor is reduced. Even should some of the propulsion current enter the relay after a train has passed, the 25 cycles would not operate it at sufficient speed to close the contacts.

The distant arms are controlled by line circuits from the signal in advance, using a three-position galvanometer relay. The line circuits are not cut through the track relays at intermediate track sections. These circuits are so designed that crosses will cause signals to assume the stop position. Signal control wires are carried in cables supported from the catenary bridges.

The trains involved in this collision were regular westbound passenger trains No. 79 and No. 5 running on track No. 3, and an extra freight train hauled by locomotive No. 1003, running westward on track No. 1.

Train No. 79, known as the "Connecticut River Special," running from Brattleboro, Vt., to New York, N. Y., was drawn by steam locomotive 1346, and was in charge of Conductor Bray and Engineman Kennedy. It consisted of the following cars in the order named:

Car.	Construction.	Date Built.	Weight.	Length over Buffers
6014 Comb. Baggage-smoker	All steel	1915	124,580	77 ft.
7866 Coach	"	1914	133,200	80 ft.3 ins.
7855 "	"	1914	133,200	80 ft. 3"
Wrentham, Pullman Parlor Car	Steel Undrfr.	1905	140,000	78 ft.6 "
Sangatuck, " " "	"	1911	142,000	79 ft.6"
Napoleon, " " "	"	1906	151,000	81 ft.7"
7901 Coach	All steel	1914	133,000	80 ft.3"

This train left New Haven on track 3 at 11.08 a.m., 29 minutes late, and passed tower 73, the last reporting station, at 11.19 a.m., and was brought to a stop about 11.21 a.m. with the rear

end about 450 feet west of signal 65.23 by the brakes going into emergency, caused by the air escaping from a cut in the air hose on the forward end of the baggage car. The train was standing in this position when it was struck by train No. 5.

Train No. 5, a local passenger train, en route from Boston to New York, was drawn by steam locomotive 824 and was in charge of Conductor Brant and Engineman Curtis. It consisted of the following cars in the order named:

Car.		Construction	Date Built.	Weight	Length over buffers.
5340	Baggage	All Steel	1915	111,680	64 ft. 9 ins.
1901	Coach	Wooden	1912	85,200	68 ft. 8 ins.
1200	Coach	Wooden	1901	69,400	68 ft. 5 ins.
1855	Coach	Wooden	1911	81,500	67 ft. 9 ins.
1827	Coach	Wooden	1911	80,660	67 ft. 9 ins.
1417	Coach	Wooden	1904	77,800	67 ft. 9 ins.

This train left New Haven on track 1 at 11.10 a.m., 21 minutes late; at tower 75 just west of New Haven station it was crossed onto track 3, passed Tower 73 at 11.22 a.m., passed automatic signal 65.93 in the caution position, struck the flagman of train No. 79, passed automatic signal 65.23 in the stop position, and while running at a speed estimated to have been between 40 and 45 miles per hour, collided with train No. 79 at about 11.24 a.m.

Freight extra 1003, consisting of 3 loaded and 35 empty cars, in charge of Conductor O'Brien and Engineman Spaulding, left New Haven on track No. 1 at 10.56 a.m., passed tower 73 at 11.21 a.m., and at the time of the collision, locomotive 1003 was nearly opposite the locomotive of train No. 79.

The collision raised the rear end of the last car of train No. 79, the end sill striking the cylinders and saddle of locomotive 824, tearing the boiler shell completely loose from the frame, the shell continuing into the body of the car about 20 feet. Illustration No. 1 shows the condition of this car after it had been picked up and moved to the shop. Illustration No. 2 shows the front end casting of engine 824 in the interior of the car.

(Illustrations Nos. 1 and 2 omitted)

The force of the impact lifted the steel car from its trucks and the car, together with the boiler shell, was forced upward and toward the south against a steel gondola car in the passing freight train, crowding it southward off the track. The forward movement of the freight train carried the steel coach

westward about 40 or 50 feet where it came to rest upon its side, completely blocking tracks 1, 2 and 4. The shell of the boiler continued on across track 4 and came to rest on its side at the foot of the embankment with its forward end even with the rear of the steel coach. After the accident the front sheet of the boiler was found to contain a puncture from 6 to 8 inches square, in the lower left hand corner slightly below the center of the fire box door. This puncture was evidently caused by some object being forced upward and backward through the fire box. The running gear of locomotive 824 was derailed, but remained upon the roadbed. The two rear cars in train No. 79 were derailed. The vestibule on the east end of Pullman car Napoleon was slightly crushed in on the left side. The floor and end sill on the west end were bent slightly upward. The roof on the west end of the car on the right side was slightly damaged, caused by its coming in contact with one of the catenary posts placed upon the right side of the track, which held the car in a partly overturned position and prevented it from rolling down the embankment. Pullman car Wrentham had its vestibule on the west end crushed in on each side and end sills bent slightly upward. Coach 7855 had its vestibule on its east end completely crushed in up to the body of the car and its seats slightly disarranged. The sills of the car remained intact. Illustration No. 3 shows the rear of this car before Pullman car Wrentham had been separated from it. Baggage car 5340, the head car of train No. 5, was telescoped a distance of about 5 feet by the tender of locomotive 824; the end sills, however, remained intact. Illustration No. 4 shows the forward end of this car after it had been taken to the shop. The front truck of this car was the only part of the train of No. 5 that was derailed.

(Illustrations Nos. 3 and 4 omitted)

When train No. 79 came to a stop its rear end was 450 feet west of signal 65.23. This signal could be seen by the engineman of an approaching train a distance of approximately 1,800 feet, by looking across the curve and through the catenary bridges. Automatic signal 65.93, the distant signal for signal 65.23, is on a tangent and can be plainly seen by the engineman of an approaching train. On account of the curve between these signals, signal 65.23 cannot be seen from signal 65.93. The grade for a distance of one mile or more east of the point of accident is slightly descending for westbound trains, and at no point is greater than one-half of one per cent. The weather at the time of the accident was clear, and the sun was shining.

After the accident both automatic signals 65.93 and 65.23 were found to be in the stop position, being held so by the

cars of the trains involved occupying the blocks. The body of Flagman Tourtelotte, of train No. 79, was found on the side of the bank to the north of track 3. His fusee and torpedoes were found near the north rail of track 3, at a point approximately 750 feet from the rear of his train. He had been struck by the engine of train No. 5.

Engineman Kennedy, of train No. 79, stated that after leaving New Haven, his train attained a speed of 45 or 50 miles per hour and that all of the signals which he passed were in the clear position; shortly after passing tower 73, the brakes went into the emergency; he got off and found the air escaping from a hole in the air hose on the head end of the baggage car and the steam heat hose between the tender and baggage car uncoupled; he was under the end of the baggage car replacing the air hose when the collision occurred and estimates that his train was pushed forward about a car length by the force of the collision. He stated that when his train stopped, he did not signal his flagman to go back with a flag, knowing the delay would be of short duration and having in mind the reliability of the flagman, and feeling that he would not wait for a signal before going back. His train stopped at 11.21 and he estimates it had been standing about 3 minutes when the accident occurred. Engineman Kennedy also stated it was his understanding that when a distant signal is found in the caution position that the speed of the train must be reduced immediately and not again accelerated until the track is indicated to be clear by the next signal.

Fireman Kantz stated that just before the train came to a stop he had put 3 or 4 scoops of coal into the fire box and had noticed the smoke through the engineman's window trailing along the side of the train. When the train stopped he went to the rear of the tender and was assisting Engineman Kennedy in replacing the air hose when the collision occurred.

Ticket Collector Russell, of train No. 79, stated that at the time his train stopped he was riding in the baggage compartment of the head car and about a minute after the train came to a stop he opened the baggage car door and looking backward saw the flagman going back with a flag.

Brakeman Tucker, of train No. 79, stated that when his train came to a stop he had just finished counting the passengers in the last car; he immediately looked out on the left side of the train and saw the engineman near the rear of the tender and upon looking backward saw that the flagman had started back with a flag in his hand. He then went forward to assist in replacing the hose and was at the head end of the train when the collision occurred at 11.24 a. m. He also stated that the wind was not very strong in any particular

direction and in his opinion there was not sufficient smoke or steam to obscure the signals from the view of the engineman of an approaching train.

Engineman Spaulding, of extra 1003, stated that after leaving New Haven his train was running at a speed of 25 or 30 miles per hour. As he approached the curve just east of the point of the accident he looked across the curve and saw a home signal on bridge 944 in the stop position but at that time he was unable to say which track the signal governed; however, as his train came closer he saw that it was signal 65.23 which governed track 3 and that signal 65.21, governing the track on which his train was running was in the clear position. He stated that as his train came around onto the tangent he discovered the rear end of train No. 79 and the flagman almost simultaneously. At that time the flagman was going back at a fast walk and had reached a point about 10 or 12 car lengths from the rear of train No. 79. As he approached the rear of train No. 79 he sounded the whistle of the locomotive to warn persons standing on the track and closed his throttle and when his locomotive had reached a point about 2 or 3 car lengths from the locomotive of train No. 79, he noticed that train surge forward and saw one of the employees that was standing at the rear of 79's engine, thrown across the track in front of his locomotive. He immediately made an emergency application of the brakes and at the same moment felt the effect of the collision on his train. His locomotive came to a stop 5 or 6 car lengths west of the locomotive of train No. 79. Engineman Spaulding further stated that according to his understanding of the rule governing distant signals, when the signal is found in the caution position, enginemen are not necessarily required to reduce speed, but must approach the next home signal prepared to stop if it is found to be in the stop position. Considering the speed of the train and the distance between the signals at this particular location, in his opinion, when signal 65.93 was found in the caution position, an engineman should have shut off steam when passing the distant signal in order to be able to stop at the next home signal. Engineman Spaulding also stated that when he first saw signal 65.23 in the stop position, there still remained a sufficient distance in which to bring his train to a stop had it governed the track on which he was running.

Fireman Kipput, of extra 1003, stated that approaching the point of the accident, he was engaged in putting coal into the fire box. He heard his engineman sound the whistle whereupon he went to the gangway and looked out, then returned to his firing and had just completed putting the coal in the fire box when the crash came. Fireman Kipput stated that the wind appeared to be from the north and in his opinion the smoke

and steam from his engine was not sufficient to obscure the signals on track 3.

Road Foreman of Engines Reichel stated that in his opinion an engineman finding signal 65.93 in the caution position should shut off at once as at that point a train will run sufficiently fast after the steam is shut off and the brakes applied to stop at the next home signal. He stated that he does not think under the worst conditions the smoke and steam at this point would be sufficient to prevent an engineman from observing the signal before passing it.

Conductor Brant, of train No. 5, stated that leaving New Haven his train ran at a reduced rate of speed through the cut, a distance of about 3/4 of a mile, after which the speed was accelerated until it reached 35 or 40 miles per hour, which speed remained practically uniform until the time of the collision. Conductor Brant stated that approaching the point of the accident he was riding in the baggage car and the first intimation of the impending accident that he received was the emergency application of the brakes followed almost immediately by the shock of the collision. Conductor Brant further stated that after the accident the body of Flagman Tourtelotte was found about two car lengths east of the rear of his train.

Baggageman Gandrup and Brakeman Short, of train No. 5, stated that after leaving New Haven yards they noticed no reduction in the speed of their train until they felt the emergency application of the brakes immediately before the collision occurred.

Ticket Collector Conwell, of train No. 5, stated that after leaving New Haven, he noticed a slight application of brakes; he is of the opinion that this application was made between West Haven and Woodmont, and at that time made a mental comment that they had caught up with train No. 79. He stated that he did not notice any application of the air brakes immediately prior to the collision.

Section Foreman Heath stated that shortly before the accident he was working on track No. 4 at a point about 600 feet west of tower 73; as No. 5 approached he looked directly at signal 65.93, being only about 100 feet distant, and at that time the top arm was in the clear position, and the bottom arm in the horizontal or caution position. As far as he could see, no reduction was made in the speed of train No. 5, either before or after it passed the signal. Immediately after the passage of the train he again looked at the signal and both arms were in the horizontal position. As the locomotive of the train went by, he noticed the engineman on the

right side and the fireman and another man on the left side of the engine, the fireman saluting him as they passed. He estimates the speed of the train at that time to have been 45 or 50 miles per hour. Shortly after the train passed he heard the crash and thinking that an accident had occurred, he hurried to the scene. Section Foreman Heath also stated that it is a frequent and an everyday occurrence for passenger trains to pass a yellow board at a high rate of speed. In his observations he had noticed that some enginemen were more cautious than others.

Signal Engineer Morrison stated that it is the standard practice of the New Haven road to install signals at least braking distance from each other, but not less than 4,200 feet apart; that under the rules an engineman receiving a caution signal, under the system in operation in this territory, is not necessarily required to reduce speed at once, but may proceed prepared to stop at the next signal in advance. He stated that in the operation of trains Nos. 79 and 5 on the day of the accident the physical conditions were such that theoretically, if each train had maintained the same relative speed after leaving New Haven, train No. 5 would have received but one distant signal in the clear position between New Haven and the point of the accident.

In discussing the operation of the signals between New Haven and Stamford, a distance of about 40 miles, Mr. Morrison stated that there were 84 signals in service; from the day they were put in operation, to the day of the accident, based on an average day's business, there had been approximately 7,132,860 signal operations. During this period there had been reported 250 instances in which signals had displayed the stop or caution indication when the clear indication should have been shown, or one safe failure for each 28,000 movements, which is 99.99 per cent perfect performance. During this same period, eight instances had been reported in which the signals had improperly displayed proceed, or one improper indication for each 891,607 movements, which is 99.999 per cent perfect performance. Below are shown the causes of the improper proceed indications and the dates on which they occurred:

July 7, 1914. Motor defect; hole in contact of centrifugal governor badly worn, causing friction which caused signal to remain in proceed position when it should have gone to stop by gravity.

August 1, 1914. Motor trouble: Armature shaft of motor out of line, causing pinion gear to stick.

January 8, 1915. Defective relay: Gummy substance formed, causing armature to fail to drop away from contact points. Gummy substance evidently got in during manufacture.

January 26, 1915. Ice on shaft bearing: Water gradually ran down from signal and collected around back of shaft bearing, froze until it held signal falsely in the clear position.

February 19, 1915. Motor sticking: In assembling motor an additional washer had been put on motor shaft which did not give armature proper end play, causing it to bind.

June 24, 1915. Obstruction in teeth of gear wheel: Teeth on motor pinion badly chipped and particles of casting got in between teeth of gear wheels causing it to bind.

October 12, 1915. Stripped gear: Gears on sector gear stripped, resulting from defective casting.

January 8, 1916. Pole changer out of adjustment: Shortening of rod due to change of temperature, prevented circuit controller or pole changer in mechanism from moving far enough to retain contact instead of breaking it.

Mr. Morrison stated that all of these improper proceed indications were caused by mechanical failures and were not failures of an intermittent character, but in each instance the signal continued to display the improper indication until repaired. He also stated that in each and every instance in which an improper signal indication had been reported, the matter had been investigated and its cause determined. Mr. Morrison further stated that a single cross or ground on any of the signal circuits would cause the signal to go to danger, and that the relays are so constructed that in the event of the 25-cycle current, used for propulsion, entering the signal circuits it would be absolutely impossible for it to cause the signals to display an improper indication.

In connection with the investigation of automatic train control devices made by the New York, New Haven and Hartford

Railroad, Mr. Morrison stated that over 4,000 plans or devices had been submitted to him for consideration, but of those submitted only two devices had any merit whatever. Later an installation of these two devices was made for the purpose of testing their efficiency. The first device tested, after a short trial, proved an absolute failure. The second device has been the subject of experiment for about a year, but has given more or less trouble and does not meet all of the requirements, and up to date has not reached a satisfactory stage of development. Mr. Morrison stated that during the tests of these two devices, in two instances a train was not stopped when it should have been, and for these failures the manufacturers were unable to account.

General Manager Bardo stated that the third man who was riding on the locomotive of train No. 5 and was killed in the accident had been identified as a former employee by the name of Sweeney. An investigation made by him disclosed that Sweeney had entered the service of the railroad company as a laborer at the round house in Stanford on January 17, 1916; he reported for duty at 6.00 a.m. on the morning of February 22d, and left the service of the company at 8.15 on the same day, after which he went to his home and told his mother that he was going to look for a better job. Mr. Bardo stated that his presence on the locomotive was unauthorized and cannot be accounted for. Mr. Bardo also stated that Engineman Curtis was fully qualified to operate any kind of a train on the road and that he had been on this particular run since December. He had known Engineman Curtis personally for 11 or 12 years; for 2 or 3 years Curtis came under his observation practically every day, and he had every reason to feel and believe that he was a thoroughly competent engineman. He had observed Flagman Tourtelotte a number of times while riding on his train and his whole makeup and manner of doing business impressed him as that of a very careful man.

In connection with the advisability of a rule which would require enginemen to shut off steam and begin to reduce speed at a caution signal, Mr. Bardo stated that he is in doubt as to whether such a rule would add any factor of safety to train operation, but was not in doubt as to the wisdom of doing anything which would keep constantly before the mind of the engineman the importance of the distant signal and if there is anything further in that way that his company can do, that they have not already done, they will be glad to do it. He stated that regarding the congestion which might result from the operation of such a rule, there is no anxiety so far as the officers of the railroad are concerned, and there should be none as far as the men employed in train service are concerned regarding the question of time. The question of time has been subordinated just as far as it is possible to do so

where the question of safety is in the least involved, and this has been impressed upon the employees in every direction. He does not believe that as a matter of everyday practice the application of such a rule would be felt one way or the other under a properly arranged automatic signal system; however, in territories where the signals are two or three miles apart, it would stand to reason that a man could hardly be expected to follow the same rule of shutting off at a distant signal. Such a rule must be susceptible to the same judgment and to the same consideration of the conditions as any other rule.

In connection with the observance of distant signals, Mr. Bardo further stated that in years gone by it probably was true that in the anxiety to maintain schedule time and keep trains moving, more attention had been paid to the home signal and its indications than had been paid to the caution signal and its indication, both in the manner of instructing the men and in the tests that have been made, but in the last three years this had not been so, because the importance of the distant signal had been emphasized just as strongly and vigorously as it could be, and with the knowledge that an engineman observes the distant signal, the officials have every reason to believe that he is going to observe the home signal.

General Manager Bardo stated that during the two years ending December 31, 1915, a total of 40,306 efficiency tests as to the observance of rules and regulations had been made by the officials of the company. These tests were subdivided into 35 different classifications and included the following: Home semaphore signal at stop, 4,611 tests; train order signal at stop, 1,564 tests; automatic signal showing stop, 2,440 tests; distant signal at caution, 2,410 tests; slow signal, yellow flag or lantern, or yellow fusee placed on track, 9,618 tests. All of the tests enumerated above resulted in a perfect performance, with one exception. In one instance, in a test of automatic signals at stop, an engineman did not come to a full stop, but reduced speed to about 4 miles per hour.

General Manager Bardo submitted a statement covering a period of 28 months from September 1, 1913 to December 31, 1915, showing that during that period, there were 56 instances reported in which enginemen had disregarded signals. This shows a marked reduction as compared with 153 such instances shown in a similar statement furnished in connection with the accident at North Haven, Conn. for a period of 32 months ending September 1, 1913.

In reply to a question as to what he would suggest as a preventive for accidents of this character, Mr. Bardo answered as follows:

"That is an exceedingly difficult question, because of the fact that regardless of what mechanically or electrically combined devices may be developed, you still go back to the human element and there is a very grave question in my mind as to the wisdom of taking from the shoulders of a well-trained, well-disciplined engineer the responsibility for doing certain things, and placing it upon a man who, by the very nature of things, can't be either so well-trained or so well-disciplined. In other words, you simply transfer the responsibility from the shoulders of one man to another, or you do a more harmful thing, you divide it between two men. Our experience, and I think the experience of every railroad and of every institution where mechanical appliances are used, is that mechanical appliances will fail, and when they fail you never can be quite sure in which direction that failure is going to go, because while it is planned and inherently set up that the failure must be in the interests of safety, the failures to which we refer in what has often been heralded as the next step in safe railroad operation, namely, the automatic train stop, is not a safe failure. It becomes at once a dangerous failure, because that takes away from the engineer the use of his intelligence and his training and his knowledge in the control and the handling of the air brakes in his train. It is well enough to say that, under the principle that the application of the brakes on a big long freight train is going to stop, but those of us who have gone through the mill appreciate that the application of the brakes upon a long freight train is something that must be handled with a great deal of intelligence, and I doubt if we will ever find a device which is going to absolutely supplant the intelligence of the engineer in that direction. We are just as anxious as anybody to find some way in which we can reduce the hazard of railroad operation."

An examination of the air hose removed from the head end of the baggage car of train No. 79, which caused the train to come to a stop, disclosed an opening about onehalf the circumference of the hose about one inch from its upper end. This opening bore evidence of having been struck a severe blow by some heavy object which cut through the hose and sheared a piece of the metal from the end of the nipple. Just below the cut the hose bore an abrasion from one to two inches in length,

indicating that it had received a glancing blow. With the hose screwed into an angle cock, in its normal position, the cut was on the top of the hose.

Car Inspector Connellan stated that on the morning of the accident he coupled engine 1346 to train No. 79 at New Haven and at that time the air hose on the head end of the baggage car was apparently in good condition.

General Air Brake Inspector Joy stated that the condition of the air hose taken from the head end of the baggage car on train No. 79 indicates that it had been hit by some hard object on its upper end, cutting through the hose and battering the end of the nipple inside. In his opinion this could have been caused by the steam hose between the tender and baggage car becoming uncoupled, the head of the steam hose striking the track and being thrown upward against the air hose.

General Car Inspector Sheehan and Mechanical Superintendent Wildin made an examination of the hose, and each stated that in his opinion the hose had not burst, but had been cut by some object. An inspection of similar equipment disclosed that if the steam hose were to become disconnected between the tender and the head car, it would be possible for either the steam hose on the rear of the tender or on the head end of the baggage car to come into contact with the ties and thus be thrown up and strike the air hose in a manner so as to make a cut similar to the one appearing on the hose under investigation.

Train No. 79 had been standing approximately three minutes and the flagman had succeeded in getting back a distance of 750 feet when he was struck and killed by train No. 5. Subsequent to the accident, a test was made in an effort to ascertain the distance that a flagman would be able to get back during the interval between the time train No. 79 stopped and the time of the collision and it was found that at a fast walk starting on the ground where the rear end of train No. 79 stood, a person in two minutes would reach a point where the evidence indicates Flagman Tourtelotte to have been struck by the locomotive of train No. 5.

It will be noted from Signal Engineer Morrison's testimony that there were 258 signal failures between New Haven and Stamford from June 3, 1914, to February 22, 1916. There are 168 signal mechanisms in this territory, with a corresponding number of relays, electric locks, indicators, etc. Based on the average daily train movement, there have been 7,132,860 signal movements. This gives one failure for each 27,600 signal movements. Of the 258 failures, eight were "improper," or "false clear" indications, an average of one for each 891,600 signal movements. All of these failures were of a mechanical

nature, and none of them were due to electrical causes. The causes, therefore, were not obscure and were not of an intermittent nature. All of them would have continued to cause failures until remedied. This is believed to be as favorable a performance as the records of most signal systems will show.

On February 26th, an inspection and test was made of the apparatus at signal locations 65.23 and 65.93. The usual tests of shunting the track circuits were made, and the mechanisms were found to operate perfectly, both for the stop and for the caution arms. The operation of the centrifugal relays at both signals, and the line relays at signal 65.93, was carefully observed. The mechanisms for signal 65.93, on top of bridge 960, were also inspected. None of the conditions causing any of the "false clear" failures mentioned by Mr. Morrison, were found to exist in the apparatus examined. Since the accident, watchmen had been on duty at both of these signal bridges and the boxes had not been opened. The track relay for track 3, at signal location 65.23, was removed and taken to the railway company's signal shops at New Haven, and there tested.

These observations and tests confirm the testimony that the signals were working properly before, at the time of, and after the accident, and the system of inspection and maintenance of the apparatus is good.

The direct cause of this accident was the failure of Engineman Curtis of train No. 5 properly to observe and be governed by the signal indications of automatic block signals 65.93 and 65.23, which are intended to prevent accidents of this character.

All of those whose testimony would throw any light on the reason why the signals were not observed and obeyed, met death in the accident, and any explanation that might be offered would simply be one of conjecture.

Engineman Curtis was a competent and trusted engineman. He was 42 years of age. He entered the service as fireman June 18, 1902, and was promoted to engineer January 29, 1907. He was reduced April 30, 1908, on account of depression in business and again promoted October 13, 1910. He passed a written examination on operating rules March 16, 1915, and has a clear service record. At the time of the accident he had been on duty about 5 hours and 9 minutes, following an off-duty period of 11 hours 26 minutes.

Flagman Tourtelotte, of train No. 79, was an experienced and trusted employee. He was 54 years of age and entered the service as gateman in April, 1900. He was promoted to passenger

trainman in June of the same year. He passed a written examination on train rules on June 15, 1915, and his service record is perfect.

In the investigation of the rear-end collision on this railroad at Stamford, Conn., June 12, 1913, it was developed that the two trains involved in that accident, left New Haven four minutes apart and in the investigation of the rear-end collision which occurred at North Haven, Conn., September 2, 1913, it was developed that six passenger trains passed Wallingford, the last reporting station prior to the place of accident, in 31 minutes and were permitted to close up within a distance of approximately ten miles. In this instance, the two trains involved left New Haven two minutes apart.

Train movements on this division are protected by automatic block signals, the vigilance of the engine crews and the alertness of the flagman. In each of these accidents, the following train ran by the signals set in the stop position. In view of these disasters, it does not appear that passenger trains in through service with but few if any stops to make, should be permitted to run so close together, if dependence for protection is to be placed upon the flagman. Protection by flagman is ineffective if sufficient time is not available for the flagman to get a proper distance from the rear of his train to afford opportunity properly to perform his duty.

It is true that on many railroads, particularly in suburban traffic, trains are run with apparent safety very close together, but these trains are not run at such high speed, stops are frequent, signals are much closer and trains are comparatively light.

If, leaving New Haven, these trains had been spaced farther apart, and each had maintained the same relative rate of speed, the flagman of train No. 79 could probably have gotten back far enough to have warned the engineman of train No. 5, had that engineman seen him, or at least to have placed torpedoes on the rail that would have been sufficient warning, so that some one on the locomotive could have brought the train to a stop and thus have averted the collision.

Train No. 79 is an express train and makes no schedule stops between New Haven and New York, and its average schedule speed is 43 miles per hour between New Haven and Woodlawn, the entrance to Grand Central Terminal Division. Train No. 5 is scheduled to leave New Haven 10 minutes behind No. 79, and is a local train making frequent stops including one at Milford, one mile west of the point of accident, and its average speed

is less than 36 miles per hour. Therefore, under normal operating conditions the headway between these two trains is sufficient to permit a flagman to get back a proper distance in case of an emergency stop even though there were no signal protection. There appears to be no reason why this practice should not have been followed on the day of the accident. Even with the trains leaving New Haven ten minutes apart, if the leading train should fail to make its schedule time, the trains would gradually close up and the only knowledge that the following train would receive that it was overtaking the preceding train, would be the signal indication. For this reason it is imperative that a train should immediately slow down upon receiving the first caution signal and be governed in like manner thereafter by each succeeding caution signal.

Figure No. 5 is a diagram indicating the operating conditions leading up to and existing at the time of the accident. The interlocking stations and the different automatic signals on track 3 are laid out to scale along the horizontal line, and time is represented on the vertical line. The records show but three times for each train, that leaving New Haven, passing Tower 75, and passing Tower 73. As there was no marked slowing-down of either train after leaving the New Haven yards, uniform speed is assumed between towers 75 and 73, which makes the time diagram for each train a straight line. The horizontal lines on the diagram, drawn from the intersections of train No. 5's time line with the vertical lines from each signal to an intersection with the time line of train No. 79, indicate where the latter train was at that particular instant. In order for train No. 5 to have received a clear indication from each distant signal, train No. 79 must have passed out of the second block in advance. The dotted horizontal lines show, except when train No. 5 was approaching signals 71.23 and 70.33, that train No. 79 was actually in the second block in advance when train No. 5 passed the second signal in the rear, where a caution indication would have been given.

The evidence seems to justify the conclusion, as is indicated on the diagram, that train No. 5 had been passing without decreasing speed, most of the distant signals at caution since leaving Tower 75. When the signal at location 65.93 was approached and, if observed, it was found that the distant arm indicated caution, on the same assumption, the engineman of train No. 5 would still consider that train No. 79 was continuing at the same speed, and that the next signal, No. 65.23, would show nothing more restrictive than caution. If, on approaching signal 65.23, something for a very brief interval took the engineman's attention from the track ahead, the stop indication would not be perceived until too late to stop.

The record in this case, together with a careful consideration of the diagram, brings forcibly to mind that the rules permit the distant signal indication to be observed with less exactness than is the home signal indication. Distant signal indications are as positive as home signal indications. Under the present practice of the New Haven Railroad, the distant signal at caution indicates to the engineman that he should prepare to stop at the next signal. This is practically the same as the standard code of the American Railway Association for three-position signaling. This is not as definite and clear-cut a rule as that given for the indication for the home signal, which says "stop," leaving in the latter case nothing to the discretion of the engineman. Without such a positive rule, especially with men feeling the pressure to make time, there is a great chance for error in reading, or for looseness in observance of, the distance signal. To be consistent with other signal rules which require a positive definite action on the part of the engineman, in order to provide proper safety in the operation of its trains, existing rules should be so modified that at the distant signal in the caution position a train shall be brought under control as quickly as possible by the engineman and maintained in such a state until the indication of the next succeeding signal is accepted. Such an observance of the caution indication would not mean delay at every distant signal, but with proper signal locations, after the second train had slowed down for the first caution signal encountered, it should receive clear signals thereafter, unless it were overtaking the preceding train. Such a practice may occasion slight delays in automatic signal territory with long blocks; nevertheless, speed must always be subordinate to safe operation.

This accident again directs attention to the fact that careful and competent enginemen, aided by signal systems of the most highly approved type, are not adequate fully to guard against the occurrence of collisions of this kind.

As all persons who could by any possibility explain why Engineman Curtis failed to obey the indication of the signals set against his train were killed in the collision, it is idle to speculate concerning the reasons why the signal indications were not obeyed; the plain, outstanding fact is the only thing that can profitably be considered. In the face of that fact there seems to be no room for doubt that to prevent accidents of this nature between high speed trains running on short headway, automatic devices which will enforce obedience to signal indications should be used.

In its report upon the accident which occurred on this railroad at Westport, Conn., on October 3, 1912, the Commission said:

"When a diversion from the lookout for a few seconds on the part of an engineer, caused by perhaps some imperative duty to be performed on the machinery in the inside of his cab, may cause disaster to his train and death to his passengers, there should be no hesitation in actively taking up the perfection and installation of such supplementary appliances as will bring the train to a stop when danger threatens. ****** Wreck prevention is the highest duty of railroads. Their obligation is not satisfied by merely making rules which prove insufficient in operation. If the "human element" repeatedly fails, then safety requires that the highest degree of mechanical skill be applied to properly supplement the human element at the particular point of danger. * * * Railroads ought to unitedly experiment with the automatic train stop until a device of practicability for general use shall be available."

Some effort has apparently been made by the New York, New Haven & Hartford Railroad Company to experiment with automatic train stop devices with a view of securing one that would be practicable for use on that railroad. Signal Engineer Morrison stated that about 4,000 different plans of automatic train stop devices had been submitted to him for examination, of which number only two were found that were thought worthy of test for the purpose of development. One of the devices tested proved an absolute failure in a very short time, and was removed; the other has been experimented with for about one year and is still being tested. Mr. Morrison stated that it does not meet all the requirements, but an effort is being made to develop some features of the device which promise to make it practicable for use.

While it is not so stated, it is probable that these two devices are selected out of the 4,000 plans submitted for the reason that, owing to the system of operation on the electric division of the New Haven Railroad, electrical devices of the direct current type cannot be used. The method of operation limits to a very considerable degree the field from which the New York, New Haven & Hartford Railroad Company is able to select automatic train stop devices. It is probable that many devices that were rejected by Mr. Morrison as being unsuited for use on his road, are capable of development for use with an electric propulsion system, but the plans presented did not so indicate, and therefore they were rejected.

The Commission has examined plans and specifications of practically all the automatic train stop devices that have

been offered for use within the past ten years, and has tested a considerable number of such devices under actual service conditions. Many of the devices thus examined and tested have been considered useful, and quite capable of development to meet general railway operating conditions. It is believed that while the New York, New Haven & Hartford Railroad Company is limited to a particular type of automatic train stop, no insuperable obstacles exist to prevent the development of alternating current devices that will prove suitable for use under the system of train operation used on the electric division of that road.

In the report of the investigation of a rear-end collision between two passenger trains made up of wooden equipment which occurred on this railroad at North Haven, Conn., on September 2, 1913, and in which 21 passengers were killed and 33 were injured, attention was called to the superiority of all-steel equipment. In the accident under investigation, the equipment in the train which was struck was of all-steel and steel underframe construction; the leading car of the second train was also of all-steel construction, and it is without doubt due to the fact that the equipment involved was of steel construction that loss of life in this accident was not much greater.

Respectfully submitted,

Chief, Division
of Safety.