November 10, 1911.

Interstate Commerce Commission,

Washington, D. C.

Dear Sirs:

On August 25, 1911, the Lehigh Valley Railroad reported by telegraph the derailment of train No. 4 near Manchester, N. Y. This derailment was caused by a broken rail and resulted in the death of 29 persons and injuries to 62 others.

Extra editions of the press gave information as to the magnitude of this accident, and I went to Manchester to make a personal investigation, instructing Inspectors Craig, Duffy and Gibbons to meet me at that place and assist in the work.

On arriving at the scene of the accident, I met Mr. Archibald Buchanan, Chief Inspector of Equipment of the Public Service Commission of the State of New York, Second District, and Mr. James Gill, his assistant, both of whom had reached there before I did. They had already taken possession of the broken rail which caused the accident, and I arranged with them for cooperation in the investigation. Mr. Buchanan and I attended the inquest held by the Coroner at Shortsville, N. Y., on August 28th, and which subsequently has been indefinitely continued.

After obtaining all the information available concerning this accident and its cause, it became apparent that it would be necessary to secure complete and definite knowledge as to the composition of the broken rail and to determine, if possible, what caused it to fail. It was therefore arranged that the Department of Commerce & Labor should have its Bureau of Standards make a complete examination of the pieces of the broken rail in order to determine the matter, and several portions of the rail were accordingly delivered to the Bureau of Standards for this purpose.

On October 3rd, Mr. James E. Howard, Engineer-Physicist of the Bureau of Standards, accompanied me to the Scene of the accident, in order to inspect the conditions existing at that point. Afterwards all the pieces of the rail which had been found, except that part which was in the possession of the Public Service Commission, were assembled in order that Mr. Howard might examine the same. On the following day Mr. Howard and I went to the mills of the Bethlehem Steel Company at Bethlehem, Pa., for the purpose of securing additional information relative to the mill practice of that company.

The report of the investigation carried on by the Bureau of Standards, together with the accompanying explanatory photographs, 27 in number, is attached to, and made a part of, this report.

Train No. 4, east-bound, left Buffalo, N. Y., at 10:35 A. M., 40 minutes late. It consisted of twelve cars, and was hauled by engines Nos. 2476 and 1804. At Rochester Junction, a station 20 miles west of the point of accident, two additional cars were picked up, so that at the time of the accident there were fourteen cars in the train, in the following order: One express car, one mail car, one baggage car, four coaches, Pullman sleeper Austin, dining car, two coaches, parlor car Emelyn, and two coaches.

On approaching the west end of the Manchester Yard, train No. 4 found the signals at caution, and, being required by rule not to exceed a speed of twenty-five miles per hour through this yard, the speed was reduced accordingly. On arriving at the east end of the yard, all of the blocks being clear, the enginemen of both engines began to use steam in order to increase the speed of the train, so that at the time of the accident the train was probably not exceeding a speed of about 25 miles per hour.

The train was derailed by a broken rail, 247 feet west of a steel girder deck bridge spanning Canandaigua Outlet, causing the death of 27 passengers and 1 employee, and injuries to 59 passengers and 4 employees. One of the injured passengers died afterwards, making a total of 29 persons killed and 62 injured.

The two engines and the first five cars were not derailed. Grand Trunk coach No. 2137, the sixth car in the train, had one truck derailed, while all of the following cars were derailed. The Pullman sleeping car Austin was leaning over to the right; the dining car was down the embankment on its side, just east of the bridge; Lehigh Valley coach No. 237, the 10th car in the train, was resting on its side in the bed of the Outlet, 40 feet below; Lehigh Valley coach No. 293, the 11th car, was standing on one end in the bed of the Outlet, the rear end of it extending about 15 feet above the top of the bridge and resting against the corner of the parlor car Emelyn, which remained on the bridge. The majority of the fatalities were in coaches Nos. 237 and 293, both of which were of wooden construction.

Lehigh Valley coach No. 237 was built by the Pullman Company in 1897. It received general repairs August 12, 1911, and was equipped with Pullman steel platforms. It was 67' 8" in length, and weighed 78,900 pounds. Lehigh Valley coach No. 293 was built by the Wason Manufacturing Company in 1907, and received light repairs on March 20, 1911. It was 76' in length and weighed 117,800 pounds. It was also equipped with Pullman steel platforms.

Although coach No. 237 had recently received general repairs, it collapsed completely when it fell into the bed of the Outlet. The ends of the car were badly broken and twisted, while the body was so badly damaged that it was destroyed.

All of the equipment on this train was carefully inspected, and both of the engines handling the train were very thoroughly examined. This examination failed to disclose any defective condition of equipment that in any way contributed to the accident, and all wheels and flanges were found to be in perfect condition.

The Lehigh Valley Railroad, at the point of the accident, maintains a double track line, running east and west, and the tracks are laid with 90-pound steel rails, 33 feet long, with class-A ties, about eighteen to the rail. Tie plates are used on each tie, and the rails are double spiked on the inside of the rail through these plates. The place of derailment is on a tangent, and the grade is practically level. The track is ballasted with crushed stone and well maintained. The bridge crossing Canandaigua Outlet is a steel girder deck bridge, about 178 feet long, of two bents, having substantial masonry abutments, with a stone pier located in the center. Each bent is supported by three steel plate girders 7' 6" in depth, and the bridge is decked with 12" x 13" timbers, each 23' in length. Each girder is securely braced with steel braces and the entire bridge is of substantial modern build.

On the north and south sides of the main tracks, west of the bridge, is the Manchester freight yard, which is a terminal for freight trains. There is a highway crossing 578 feet west of the bridge, and the freight train yard is located west of this crossing. There is a cross-over between the street crossing and the bridge for the purpose of handling engines and cars to and from the engine house and the west-bound yards, on the north side of the main track, and the east-bound yards, on the south side of the main track. The east switch point of this cross-over is 208 feet west of the bridge. This cross-over is an interlocker, and all the switches and signals are handled by a towerman located just east of the street crossing.

Trains are operated over this division by the Hall Automatic Block Signal System, and the signals governing the cross-over switches in the east end of the Manchester yard are electrically connected with the block signal system, so that if in any way the circuit between two blocks is broken, the semaphore would indicate danger and could not be mechanically lowered to safety by the towerman. The fact that all of the signals were set at clear by the towerman makes it evident that the rail that caused this accident was not broken prior to the time train No. 4 entered this block. This being true, it is very probable that as steam was just being admitted to the cylinders of both engines, in order to get the train under full headway, it withdrew much of the load from the pilot wheels, resulting in an excessive load on the driving wheels, thus applying a maximum wheel pressure to this defective rail, causing it to break under one of the engines. The cars immediately following the engines, although passing over this rail without being derailed, nevertheless caused additional fractures until, its continuity being destroyed, the forward trucks of the sixth car dropped to the ties. This conclusion is established by the battered condition of the west ends of pieces of the rail found after the accident, as shown by photographs Nos. 9 and 11 attached to the report of Mr. Howard.

The total weight of the two engines was distributed as follows:

Weight	No.2476	No.1804
On driving wheels	99,700	154,800
On trucks, front	53,800	44,700
On trucks, back	43,000	
Total engine	196,500	199,500
Total engine and tender	339,200	342,200
Number and diameter of driving wheels	2 pr. 77"	3 pr. 69"

Wheel Base		
Driving	6' 11"	14' 1"
Rigid	14' 1"	14' 1"
Total engine	25' 8"	26' 1"
Total engine and tender	69' 9½	67' 1½"

The broken rail causing this accident was manufactured by the Bethlehem Steel Company, open hearth process, 20% discard, 90 pounds to the yard, and was rolled December 24, 1909, heat No. 14208. It was what is known as an "A" rail, which is the first rail rolled from the ingot. This rail was first laid in the main track of the Lehigh Valley Railroad on October 31, 1910, at which time it was a 30-foot rail. On account of placing a new frog in the cross-over previously mentioned, in the latter part of April, 1911, the length of this rail was shortened to 24 feet, and it was again laid in the track. After the accident it was found that this rail had been broken into many pieces, the first being 31 inches in length, the next 27 inches, the next 22 inches, etc. Seventeen pieces of the 24-foot rail were found, while a part of it has never been located. Inspection showed that it was defective, being what is known as a "piped rail." Analysis of this defective part shows that piping is due to slag originating in the steel furnace. In the examination of the rail, after the accident, the piping or slag split could be seen in practically every portion of it.

In the head of this rail there were transverse fissures, and from the report of Mr. Howard it appears that defects of this character can not be detected except by chance. It further appears that they are of a more dangerous character than piping, since they are developed after the rail is laid. Mr. Howard further states that the rolling of the head of the rail by heavy wheel pressures introduces internal strain in the steel. This strain reaches its greatest intensity on the guage side of the head of the rail, where the flow of the steel takes place in a lateral direction. It is further shown that no foreign substance in the steel is needed to account for the presence of these fissures, and that they invariably occur on the gauge side of the rail. From these and other facts set forth, it seems that these fissures are not defects of mill practice and that they do not exist in a new rail before it is laid.

The report of Mr. Howard further states that the development of these transverse fissures suggests that the limit of wheel pressures has been reached, and probably surpassed, on rails of the usual width and shape of head, and that the increasing occurrence of accidents of this character is a warning of this fact.

In this connection it might be well to call attention to the fact that the accident reports of the Commission show that in 1902 there were 78 derailments due to broken rails, while in 1911 there were 249 derailments due to the same cause. In the past decade there have been 2,059 derailments caused by broken rails, resulting in 106 killed and 4,112 injured.

Our investigation further disclosed the fact that the Lehigh Valley Railroad was cognizant of the fact that there were defective rails in service of the character of the rail here in question, as evidenced by the following letters of instructions to subordinates:

Buffalo, N. Y., Dec. 13, 1910.

File No. 118.

Mr. M. J. Greeney,
Mr. P. M. Dinan,
Mr. R. M. Doyle,
Mr. John Nash,

Gentlemen:

Our attention is called to the necessity of more careful watching for defective rails during the coming cold weather, when rails with slight defects are more liable to fail than in the warmer weather. Any rails which show any indication of piping, cracks or other defects, should be weeded out promptly, and a constant lookout should be kept by section foremen and track walkers for any indication of visible defects.

Yours truly,

R. T. Reisler,

Division Engineer.

Manchester, N. Y., Dec. 17, 1910.

ALL FOREMEN:

We are still having a few piped rails found in main tracks. These rails can be detected by watching the top of the ball of the rail closely, and if you notice any black lines or crushing at the head, remove rail at once.

Yours truly,

F. M. Doyle,

Supervisor.

These orders were issued prior to the time that this rail was cut from a 30-foot rail to a 24-foot rail. Not only was the rail cut, but three one-inch holes were drilled through the webb of the rail near the cut end, each of which, as well as the cut end of the rail, clearly showed, after the accident, evidence of the piping mentioned. This rail was cut and laid about four months prior to the accident, and, on account of the unmistakable evidence of piping found after the accident, it would appear that this defect could and should have been discovered before relaying the rail.

This accident was caused by a broken rail. The primary cause of the broken rail was the formation and development of transverse fissures and longitudinal seams in the head of this rail, finally causing it to break under the extreme wheel pressure to which it was subjected. A secondary cause of the breaking of the rail was the piping, which is a defect of mill practice.

The defects existing in the rail that caused this accident, both piping and fissures, were of such a nature that once the rail was placed in the track, careful inspection would fail to disclose them.

When this rail was cut and relaid, new holes had to be drilled for the fish plates, and those holes, as well as the cut end, must have shown evidence of the piping mentioned. This defect, therefore, could and should have been discovered at that time, and the rail should not have been put back into service.

With the information at present available, it is extremely difficult to suggest any preventative of future accidents of this character. From such information as is at hand, however, it seems apparent that the remedy lies in the diminishing of the wheel pressures and the lowering of direct compressive and bending stresses. The report of Mr. Howard clearly shows that exhaustive experiments and tests should be begun, and that a most complete and searching examination should be made of the whole question. This examination should deal with steel rails from the furnace to the time they are laid in the track; it should determine whether the tests now used in the steel mills are adequate to detect imperfect rails; it should ascertain whether the use of high carbon steel is not attended with dangers not recognized in the drawing up of current specifications; it should be extensive enough to inquire into the causes which contribute toward such a destruction of the structural integrity of the steel as was the case with this rail; it should take up the securing of measurements in the track of the actual fibre stresses which are caused by the new types and weights of locomotives, and under the different wheels of those locomotives, in order to obtain information from which to judge of the severity of the strains to which the track is daily subjected; in fact, track conditions as they exist at the present time should be dealt with even to the most minute detail.

From the report of Mr. Howard, it would thus appear that the danger zone in the use of steel rails as at present manufactured has been reached, and, since it is supposed that transverse fissures are the direct result of high wheel pressures acting on hard steel, a complete investigation should be made for the purpose of scientifically determining the matter and ascertaining a remedy. Until such an investigation has been made, the danger of similar accidents will exist. Such an investigation is therefore recommended.

Respectfully submitted,

Chief Inspector of
Safety Appliances.