No. 183

In re: Investigation of accident which occurred on the Chicago & Alton Railroad near Lockport, Illinois, on January 31, 1914.

Derailment of a passenger train near Lockport, Ill., on January 31, 1914, resulting in the injury of 14 passengers. This accident was caused by a broken rail.

The division on which this accident occurred is a double-track line, train movements being governed by automatic block signals. The derailment occurred on a tangent about 800 feet south of a 2 degree curve, and on a grade of .075%, descending for southbound trains. The track is laid with 80-pound steel rails, 30 feet in length, with about 17 ties under each rail, and laid on about 10 inches of crushed limestone ballast.

Southbound passenger train No. 7, en route from Chicago, Ill., to St. Louis, Mo., consisted of 1 combination car and 1 chair car, both of wooden construction, 1 Pullman sleeping car of steel construction, 3 Pullman sleeping cars equipped with steel underframes, 5 Pullman sleeping cars of wooden construction, 1 wooden cafe-observation car, and locomotive 658. This train left Chicago at 11.59 p. m., passed Lambert, Ill., the last telegraph station north of the point of derailment, and nearly 12 miles distant therefrom, at 12:54 a. m., being 14 minutes late at the time, and at 1.08 a. m. was derailed at a point about one-half mile south of Lockport while running at a speed estimated to have been about 35 miles per hour.

The locomotive and first car were not derailed, and came to a stop at a point about 600 feet beyond the initial point of derailment. The rear truck of the second car, together with the third and fourth cars, were derailed, the fifth car turned over on its side, while the remaining four cars were derailed but remained upright. A heavy snow was falling at the time.

The engineman and fireman stated that their first knowledge that anything was wrong was when the air brakes were applied and only. At the time they thought this had been occasioned by a broken air hose, not discovering that the cars in the train had been derailed until they went back to look for the air hose they supposed to be broken. Neither of them felt any jar or unusual motion of the locomotive up to the time the brakes were applied.

Examination of the locomotive and cars showed nothing which in any way could have caused the derailment. Examination of the track showed that there was a broken rail on the east side of the track. The northern or receiving part of the rail was intact for a distance of 21 feet, the next 7 feet were broken into several pieces, while the remaining 2 feet of rail on the leaving end were intact. The first marks of wheel flanges were found to be upon the ties south of the broken end of the 21-foot piece of rail.

The rail was an 80-lb A.C.E. section, rolled by the Cambria Steel Company in August, 1900, and placed in the track in December of that year.

An investigation to determine the cause of the failure of the rail was conducted by the Bureau of Standards. The report of the Bureau states that specimens of the rail were subjected to tensile and hardness tests, metallographic examination and chemical analysis.

Quoting from the report of the Bureau, it was stated that the hardness tests indicated the metal of the rail to be very heterogeneous, the extreme variation in hardness being 28.6% of the mean value. That the extreme variation in tensile strength was 14.6%.

The minimum tensile strength reported was 110,000 lbs. per sq. in., the maximum 127,500 lbs. per sq. in., the minimum value pertaining to the metal of the head, the maximum to that of the web.

The chemical analysis gave the following results:

Position in the rail.	Position of Sample in cross-section. (See diagram.)	C	S	P	Mn	Si	Oxides & Slag
	Near running surface of head.	.55	.059 .054	.100	.99	.079	
Back end 10" from outer end of long fragment.	Side of Head	.53	.051 .050	.093	.94	.077	
	Center of Head next split	.57	.066	.120	1.01 1.00	.084 .089	
	Web.	.35	.081 .082	.132	.94	.070 .068	
	Base	.56	.060	.100	.98	.068 .068	
	Near running surface of Head.	.55	.057 .059	.106	.99	.070	.14
From one of the fragments of the shattered portion.	Side of Head	.57	.053	.100	1.01	.068	.16
	Center of Head next web.	.60	.057 .056	.118	.98	.068	.15
	Web	.65	.090 .085	.113	1.00	.068	.37
	Base	.58	.054	.100	.90	.070	.16

The average carbon content is above the maximum of most specifications for rails of this weight and kind. The segregation in the center of the head and web gives a carbon content considerably above this maximum in these portions of the rail. The phosphorus content is high; with one exception the amount found is either the maximum allowed for rails of this kind by most specifications (.10) or above this maximum.

The results of the metallographic examination were summarized as follows:

1. The amount of segregation as shown by the macroscopic examination, except in the web, is not excessive and in the fractured portions appears somewhat less than in the long unbroken fragment.

2. No appreciable segregation in the head directly adjacent to the split was found.

3. The metal of the web lacks homogeneity and has a streaked and laminated appearance -- the central portion being high enough in the carbon to give the metal the appearance of that of eutectoid composition.

4. The microstructure of all portions examined, excepting the central part of the web, is very uniform throughout, the 'slag threads' being the only noticeable features suggestive of faulty material. There is some evidence shown by the samples from near the running surface of the cold rolling the metal has received.

5. No positive evidence was found showing that the split was the result of a previously existing 'pipe' in the head of the rail.

In conclusion the Bureau reported that the rail was found to have the following characteristic properties:

1. The rail material is a Bessemer steel having an average carbon content above the maximum of most specifications for rails of this type and a phosphorus content which, with one exception, either equals or is above the maximum (.10) allowed for such rails.

2. There is a pronounced, though not excessive, segregation in the fractured portion of the rail, somewhat less in the long unbroken fragment and not appreciable segregation in the portions of the head directly adjacent to the split.

3. Both the hardness tests and the macroscopic examination show the rail to lack homogeneity. The latter shows the web to be badly streaked and laminated, and the head, except at the end furthermost from the break, to be fairly sound and without much heterogeneity.

As no positive evidence was found that the split was the result of a previously existing pipe in the head of the rail, it may have been that the split in the rail was formed during service and was caused by excessive stresses which are, of course, the resultant of the initial stresses, temperature stresses and load stresses, the latter including any effects caused by defects of the road bed, flat wheels, swaying and vibration of the rolling stock and the reciprocating parts of the engine.

To avoid such failures as this the rails ought to be made of more homogeneous material and with a greater factor of safety, and the road bed ought always to be in the best condition.

The question may still be asked, however, whether in spite of the fact that there was no excessive segregation, the split in the head of the rail may not have been caused by a pipe, since the existence of a pipe in a rail ingot may be accompanied by no more marked segregation along portions of its length than are shown for this rail.