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*** START OF THE PROJECT GUTENBERG EBOOK TRANSACTIONS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, VOL. LXX, DEC. 1910 ***

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

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TRANSACTIONS

Paper No. 1177

**FINAL REPORT OF SPECIAL COMMITTEE
ON RAIL SECTIONS. [A]**

Your Special Committee on Steel Rails, since their appointment in 1902, have held numerous meetings, not only of their own body, but also in conference with Committees representing other Societies and the steel rail makers. The results of their deliberations have been presented to the Society in their reports presented on—

January	21st,	1903 ^[B]
"	18th,	1905
"	17th,	1906
"	16th,	1907
July	9th,	1907
December	6th,	1907
"	18th,	1908
November	30th,	1909

As previously reported to you, the Rail Committee of the American Railway Engineering and Maintenance of Way Association is also acting for the American Railway Association; and the latter organization has guaranteed to it the necessary funds to make exhaustive tests and observations as to the wear, breakage, etc., etc., of steel rails. This work is being prosecuted, and will of necessity require several years.

Your Committee feels that it has nothing to add to the several reports which it has presented to the Society, particularly as, so far, the several cardinal principles outlined in them are being practically followed in the several used and proposed specifications and rail sections.

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In view of the foregoing, your Committee would respectfully ask to be discharged so that the field may be clear if at any future time the Society should desire to again place the subject in the

hands of a Committee.

JOSEPH T. RICHARDS,
C. W. BUCHHOLZ,
E. C. CARTER,
S. M. FELTON,
ROBERT W. HUNT,
JOHN D. ISAACS,
RICHARD MONTFORT,
H. G. PROUT,
PERCIVAL ROBERTS, JR.,
GEORGE E. THACKRAY,
EDMUND K. TURNER,

Approved in connection with the attached report:

WILLIAM R. WEBSTER.

JUNE, 1910.

PHILADELPHIA, JUNE 1ST, 1910.

I have signed the Report of the A. S. C. E. Rail Committee,—“Approved in connection with the attached report,” as I feel that the report is too condensed, and assumes that all are familiar with the Rail situation, especially what has been done by the other Societies.

The work undertaken by this Committee has been delegated by The American Railway Association to the Rail Committee of The American Railway Engineering and Maintenance of Way Association, and it therefore seems appropriate to give the results of their work, up to date, to our members in convenient form for reference, especially as our rail specifications have not been worked to, and they have offered a better specification that will be worked to, and no doubt largely used by the members of this Society. The specification is attached to this report.

In presenting this specification to the Annual Meeting at Chicago in March last, the Committee said:^[C]

“A new specification should not be proposed at this time without careful consideration. So far as we know, no railroad company has purchased rails under the specifications approved by the American Railway Association and referred to us; nor do we know of any railway company that has succeeded in buying rails during the past two years according to a specification entirely satisfactory to the railroad company. We believe that all of the specifications under which rails have been rolled have been compromises on the part of both parties, with the general result that neither party is entirely satisfied. Our experience during the year has brought to our attention some defects in all of the specifications now before us, and acting under the impression that there is a distinct feeling that we should revise our specifications, we offer the attached specifications for your consideration. Our Association has no specification for Open-Hearth Steel Rails, and in order to comply with the instructions, a specification for Open-Hearth Steel Rails is included.

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“We believe it necessary to submit a sliding scale for the percentages of carbon and phosphorus, which provides for increasing the carbon as the phosphorus decreases. The fixing of this scale properly is a matter requiring care, and we admit that our knowledge on the subject is limited. The American Railway Association specification calls attention to this matter in the following words: ‘When lower phosphorus can be secured, a proper proportionate increase in carbon should be made.’ The amount of increase is not provided for in the specifications, and this appears to us to be necessary in order to secure uniformity of practice; otherwise, the fixing of these percentages becomes a matter of special arrangement. Bessemer rails are being furnished regularly with phosphorus under the maximum allowed, and where this is done, the carbon should be raised above the higher limit now fixed in our specifications, or a soft and poor wearing rail will result; yet this condition has not been fully guarded against in rails furnished under existing specifications. The lower and upper limits for carbon have heretofore been fixed with the intention that the mills furnish rails with a composition as near between the two limits as possible. The mills, however, in order to meet the prescribed drop tests with the least difficulty, keep both the carbon and manganese as nearly as possible to the lower limits, with the corresponding result that a generally poor-wearing rail is furnished.

“Some roads have prescribed the limits of deflection to be allowed under the drop test. With our present knowledge, we believe that we should fix a minimum deflection to eliminate brittle rails and to secure greater uniformity of product; also maximum deflection to eliminate soft rails. We are not able at the present time to fix these limits, but our ultimate object will be to determine and fix such limits for the specifications.

“With reference to the amount of discard, time of holding in ladle, size of nozzles,

and other such details of manufacture or machinery, we are of the opinion that the physical and chemical tests required should be prescribed, and that we should see that the material submitted for acceptance meets the prescribed tests. We should not dictate to the manufacturers the amount of crop which shall be removed from the top of the ingot, as this should vary with the care and time consumed at the various mills. The railroads should not be asked to take anything but sound material in their rails. The mills can furnish such sound material if the proper care and sufficient time are taken in the making of the ingots. Information derived from the tests being made at the Watertown Arsenal shows definitely that sound rails cannot be made from unsound ingots, and that, therefore, the prime requisite in securing a sound rail is to first secure the sound ingot.

"We recommend that the present Specifications for Steel Rails be withdrawn from the Manual of Recommended Practice of the Association, as no longer representing the current state of the art.

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"We submit herewith, as Appendix 'A,' a form for specifications. It will have to be amended from time to time as we receive further information on the subject."

The specifications referred to above were modified and presented at the Meeting in *Supplement to Bulletin No. 121*, of March, 1910, and in this final form are attached hereto.

These specifications do not represent the work of any one Society or the work of any one Committee, but are the result of all the work of the different Societies, as the members of all are so interwoven that whatever work is done in any one Society, or by the Committee of a Society, has very naturally and fortunately been carried into the others.

At the Chicago Meeting these specifications were accepted without a single change, and this is very unusual and shows how generally acceptable they were, as the members of all Rail Committees were present at the Meeting. The main points in this specification were discussed and agreed upon by the members of the Committee and the Rail Committee of the manufacturers who have co-operated with them in this work.

In the matter of Rail Sections, the Rail Committee of The American Railway Engineering and Maintenance of Way Association has not arrived at any definite conclusions. The new sections "A" and "B" of The American Railway Association have not given as good results as was expected of them, and the whole matter is yet under consideration. The Committee reported as follows:^[D]

"The instructions of the American Railway Association require us to study the A. R. A. sections 'A' and 'B' in use and submit a single type for standard. Owing to the conditions existing in 1908, very little rail was laid, and practically none of the A. R. A. sections, in such manner as to give the needed information. This year, several roads have laid A. R. A. sections of rail, with a view of determining the relative merits of the respective sections. These rails have been in the track so short a time that we are not justified in drawing any conclusions as to which of the A. R. A. types, 'A' or 'B,' or if either, is better than the A. S. C. E. sections.

"*Bulletin No. 116*, issued October, 1909, gives the statistics for rail failures for six months from October 31, 1908, to April 30, 1909, as reported to the Committee. These statistics do show that the difference in section can be entirely annihilated by difference in chemical composition and by the treatment in furnace and mill.

"The results so far obtained from the heavy base A. R. A. sections are disappointing, as we have received some rail from the mills of the new section which was as bad as we did with the old A. S. C. E. section, showing that the quality of the rail does not depend entirely upon the section.

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"The tests to be inaugurated by the Committee, combined with the results of the tests at Watertown and the performance of the rail in the track, will give us valuable data to aid us in coming to a final conclusion."

A careful study of the results already obtained, on both Bessemer and open-hearth steel rails, indicates that the next necessary step will be the use of a much heavier rail, and I think the sooner this is admitted and trial lots of say 1,000 tons each of 110-lb., 120-lb. and 130-lb. rails rolled, of Bessemer and open-hearth steel, and put in service under the most severe conditions, the sooner we will get rid of the present difficulties with our rails.

WM. R. WEBSTER.

"SPECIFICATIONS FOR STEEL RAILS."^[E]

"1. The entire process of manufacture shall be in accordance with the best current state of the art.

"(a) Ingots shall be kept in a vertical position until ready to be rolled, or until the metal in the interior has had time to solidify.

"(b) Bled ingots shall not be used.

Process
of
manufacture.

"2. The chemical composition of the steel from which the rails are rolled shall be within the following limits:

Chemical composition.

	BESSEMER.		OPEN-HEARTH.	
	70 lbs. and over, but under 85 lbs.	85 to 100 lbs. inclusive.	70 lbs. and over, but under 85 lbs.	85 to 100 lbs. inclusive.
Carbon	0.40 to 0.50	0.45 to 0.55	0.53 to 0.66	0.63 to 0.76
Manganese	0.80 to 1.10	0.80 to 1.10	0.70 to 1.00	0.70 to 1.00
Silicon	0.07 to 0.20	0.07 to 0.20	0.07 to 0.20	0.07 to 0.20
Phosphorus, not to exceed	0.10	0.10	0.04	0.04
Sulphur, not to exceed	0.075	0.075	0.06	0.06

"3. When the average phosphorus content of the ingot metal used in the Bessemer Process at any mill is below 0.08 and in the Open-Hearth Process is below 0.03, the carbon shall be increased at the rate of 0.035 for each 0.01 that the phosphorus content of the ingot metal used averages below 0.08 for Bessemer steel, or 0.03 for Open-Hearth steel.

"The percentage of carbon in an entire order of rails shall average as high as the mean percentage between the upper and lower limits.

"4. The end of the bloom formed from the top of the ingot shall be sheared until the entire face shows sound metal.

Shearing.

"All metal from the top of the ingot, whether made from the bloom or the rail, is the top discard.

"5. The number of passes and speed of train shall be so regulated that, on leaving the rolls at the final pass, the temperature of the rails will not exceed that which requires a shrinkage allowance at the hot saws, for a 33-ft. rail of 100 lb. section, of 6-1/2 in. for thick base sections and 6-3/4 in. for A. S. C. E. sections, and 1/8 in. less for each ten pounds decrease of section, these allowances to be decreased at the rate of 1-100 in. for each second of time elapsed between the rail leaving the finishing rolls and being sawed.

Shrink

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"The bars shall not be held for the purpose of reducing their temperature, nor shall any artificial means of cooling them be used between the leading and finishing passes, nor after they leave the finishing pass.

"6. The section of rail shall conform as accurately as possible to the templet furnished by the Railroad Company. A variation in height of 1-64 in. less or 1-32 in. greater than the specified height, and 1-16 in. in width of flange, will be permitted; but no variations shall be allowed in the dimensions affecting the fit of splice bars.

Section

"7. The weight of the rail shall be maintained as nearly as possible, after complying with the preceding paragraph, to that specified in the contract.

Weight

"A variation of one-half of one per cent. from the calculated weight of section, as applied to an entire order, will be allowed.

"Rails will be accepted and paid for according to actual weight.

"8. The standard length of rail shall be 33 ft.

Length

"Ten per cent. of the entire order will be accepted in shorter lengths varying by 1 ft. from 32 ft. to 25 ft.

"A variation of 1/4 in. from the specified lengths will be allowed.

"All No. 1 rails less than 33 ft. shall be painted green on both ends.

"9. Care shall be taken in hot-straightening rails, and it shall result in their being left in such condition that they will not vary throughout their entire length more than four (4) in. from a straight line in any direction for thick base sections, and 5 in. for A. S. C. E. sections when delivered to the cold-straightening presses. Those which vary beyond that amount, or have short kinks, shall be classed as second quality rails and be so marked.

Finishing

"The distance between supports of rails in the straightening press shall not be less than forty-two (42) in.; supports to have flat surfaces and out of wind. Rails shall be straight in line and surface and smooth on head when finished, final straightening being done while cold.

"They shall be sawed square at ends, variations to be not more than 1-32 in., and

prior to shipment shall have the burr caused by the saw cutting removed and the ends made clean.

"10. Circular holes for joint bolts shall be drilled in accordance with specifications of the purchaser. They shall in every respect conform accurately to drawing and dimensions furnished and shall be free from burrs.

Drilling

"11. The name of the manufacturer, the weight of the rail, and the month and year of manufacture shall be rolled in raised letters and figures on the side of the web. The number of the heat and a letter indicating the portion of the ingot from which the rail was made shall be plainly stamped on the web of each rail, where it will not be covered by the splice bars. Rails to be lettered consecutively A, B, C, etc., the rail from the top of the ingot being A. In case of a top discard of twenty or more per cent. the letter A will be omitted. Open-Hearth rails to be branded or stamped O. H. All marking of rails shall be done so effectively that the marks may be read as long as the rails are in service.

Branding

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"12. (a) Drop tests shall be made on pieces of rail rolled from the top of the ingot, not less than four (4) ft. and not more than six (6) ft. long, from each heat of steel. These test pieces shall be cut from the rail bar next to either end of the top rail, as selected by the Inspector.

Drop testing.

"The temperature of the test pieces shall be between forty (40) and one hundred (100) degrees Fahrenheit.

"The test pieces shall be placed head upward on solid supports, five (5) in. top radius, three (3) ft. between centers, and subjected to impact tests, the tup falling free from the following heights:

70 lb. rail	16 ft.
80, 85 and 90 lb. rail	18 ft.
100 lb. rail	20 ft.

"The test pieces which do not break under the first drop shall be nicked and tested to destruction.

"(b) (It is proposed to prescribe, under this paragraph, the requirements in regard to deflection, fixing maximum and minimum limits, as soon as proper deflection limits have been decided upon.)

"13. (A) Two pieces shall be tested from each heat of steel. If either of these test pieces breaks, a third piece shall be tested. If two of the test pieces break without showing physical defect, all rails of the heat will be rejected absolutely. If two of the test pieces do not break, all rails of the heat will be accepted as No. 1 or No. 2 classification (according as the deflection is less or more, respectively, than the prescribed limit^[F]).

Tests.

"(B) If, however, any test piece broken under test A shows physical defect, the top rail from each ingot of that heat shall be rejected.

"(C) Additional tests shall then be made of test pieces selected by the Inspector from the top end of any second rails of the same heat. If two out of three of these second test pieces break, the remainder of the rails of the heat will also be rejected. If two out of three of these second test pieces do not break, the remainder of the rails of the heat will be accepted, provided they conform to the other requirements of these specifications, as No. 1 or No. 2 classification (according as the deflection is less or more, respectively, than the prescribed limit^[F]).

"(D) If any test piece, test A, does not break, but when nicked and tested to destruction shows interior defect, the top rails from each ingot of that heat shall be rejected.

"14. The drop-testing machine shall be the standard of the American Railway Engineering and Maintenance of Way Association, and have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of five (5) in.

Drop testing machine.

"The anvil block shall be adequately supported and shall weigh 20,000 lbs.

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"The supports shall be a part of or firmly secured to the anvil.

"15. No. 1 rails shall be free from injurious defects and flaws of all kinds.

No. 1 Rails.

"16. Rails which, by reason of surface imperfections, are not accepted as No. 1 rails, will be classed as No. 2 rails, but rails containing physical defects which impair their strength, shall be rejected.

No. 2 Rails.

"No. 2 rails to the extent of five (5) per cent. of the whole order will be received. All rails accepted as No. 2 rails shall have the ends painted white, and shall have two prick punch marks on the side of the web near the heat number near the end

of the rail, so placed as not to be covered by the splice bars.

"Rails improperly drilled, straightened, or from which the burrs have not been properly removed, shall be rejected, but may be accepted after being properly finished.

"Different classes of rails shall be kept separate in shipment.

"All rails shall be loaded in the presence of the inspector.

"17. (a) Inspectors representing the purchaser shall have free entry to the works of the Manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the Manufacturer to satisfy them that the rails have been made in accordance with the terms of the specifications.

Inspection.

"(b) For Bessemer Steel the Manufacturer shall, before the rails are shipped, furnish the Inspector daily with carbon determinations for each heat, and two complete chemical analyses every twenty-four hours representing the average of the other elements specified in section 2 hereof contained in the steel, for each day and night turn respectively. These analyses shall be made on drillings taken from the ladle test ingot not less than 1/4 in. beneath the surface.

"For Open-Hearth Steel, the makers shall furnish the Inspectors with a complete chemical analysis of the elements specified in section 2 hereof for each melt.

"(c) On request of the Inspector, the Manufacturer shall furnish drillings from the test ingot for check analysis.

"(d) All tests and inspections shall be made at the place of manufacture, prior to shipment, and shall be so conducted as not to unnecessarily interfere with the operation of the mill."

FOOTNOTES:

[A] Presented to the Annual Convention, June 21st, 1910.

[B] These reports were published in *Proceedings*, Am. Soc. C. E., as follows: February, 1903, p. 43; February, 1905, p. 60; February, 1906, p. 50; February, 1907, p. 69; August, 1907, p. 290; February, 1908, p. 85; February, 1909, p. 61; February, 1910, p. 62.

[C] Bulletin No. 118, December, 1909.

[D] Bulletin No. 118. December, 1909.

[E] Reprinted from *Supplement to Bulletin No. 121* of the American Railway Engineering and Maintenance of Way Association (March, 1910).

[F] Note: The clause in brackets in Sections A and C to be added to the specifications when the deflection limits are specified.

*** END OF THE PROJECT GUTENBERG EBOOK TRANSACTIONS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, VOL. LXX, DEC. 1910 ***

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