

SPECIFICATIONS FOR CARBON STEEL RAILS.

INSPECTION.

1. ACCESS TO WORKS. 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 and loaded in accordance with the terms of the specifications.

2. PLACE FOR TESTS. All tests and inspections shall be made at the place of manufacturer prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the mill.

MATERIAL

3. The material shall be steel made by the Bessemer or open-hearth process, as provided by the contract.

CHEMICAL REQUIREMENTS

4. The chemical composition of the steel, determined as prescribed in section 6, shall be within the following limits: (See the table at the end.)

5. AVERAGE CARBON. It is desired that the percentage of carbon in an entire order of rails shall average as high as the mean percentage between the upper and lower limits specified.

6. ANALYSES. In order to ascertain whether the chemical composition is in accordance with the requirements, analyses shall be furnished as follows:

(A) BESSEMER PROCESS: The manufacturer shall furnish to the inspector daily, carbon determination for each heat before the rails are shipped, and two chemical analyses every 24 hours representing the average of the elements, carbon, manganese, silicon, phosphorus and sulphur contained in the steel, one for each day and night turn, respectively. --- These analyses shall be made on drillings taken from the ladle test ingot not less than 1/8 in. beneath the surface.

(B) Open-Hearth Process. (a) Finished Rail Analysis. On each heat the manufacturer shall make an analysis of the elements, carbon, manganese, phosphorus, sulphur and silicon. A copy of the results shall be given to the inspector. Drillings for these analyses shall be taken longitudinally of the rail with a 1/2 in. drill, close to an upper corner of the head from any one of the three drop test pieces representing the top of the ingot, or from pieces cut adjacent to any one of these three drop test pieces.

(b) Ladle Analyses. For the information of the inspector the manufacturer shall furnish a chemical analysis of the elements, carbon, manganese, silicon, phosphorus and sulphur, for each heat. These analyses shall be made on drillings taken from the ladle test ingots not less than 1/8 in. beneath the surface.

(C) Check Analysis. On request of the inspector, the manufacturer --- shall furnish a portion of the ladle test ingot for the Bessemer process and a portion of the drillings from the finished rail for the open- --- hearth process for check analysis. When made a part of the contract, -- the manufacturer shall furnish the necessary facilities at the mill for the purchaser's representative to make the check analysis.

(D). When the analyses for carbon by the mill chemists and by the railroad chemist do not agree, a tolerance of two points below the minimum-- and two points above the maximum will be allowed to cover such variation before condemnation.

PHYSICAL REQUIREMENTS.

7. Physical Qualities. Tests shall be made to determine:

- (a) Ductility or toughness as opposed to brittleness;
- (b) Soundness.

8. Method of Testing. The physical qualities shall be determined by:-

- (a) The drop test, or
- (b) The quick bend test, if made a part of the contract.

9. Drop Testing Machine. The drop testing machine used shall be the standard of the American Railway Engineering Association, the essential parts of which are:

(a) The tup shall weigh 2,000 lb., and have striking face with a radius of 5 in.

(b) The anvil block shall weigh 20,000 lb., and be supported on springs.

(c) The supports for the test pieces shall be part of, and firmly secured to, the anvil; their bearing surfaces shall have a radius of 5 in.

(d) The spacing of the supports between centers shall be: 3 feet for rails weighing 110 lb. or less per yard; 4 feet for rails weighing from 111 to 140 lb. per yard, inclusive.

10. Machine for Quick Bend Test. The quick bend test shall be made with a hydraulic press of not less than 350 tons capacity, some of the details of which are as follows:

(a) The foundations for the supports of the test specimens shall be adequate to sustain rigidly the total load applied by the press.

(b) The supports shall be solid flat bearing surfaces with vertical faces 48 in. apart, with the inner edges rounded to a 1/8 in. radius.

(c) The head of the ram shall have a bearing face with a radius of 5 in.

(d) The speed of the ram shall approximate 13 ft. per minute when allowed free travel.

(e) A hydraulic indicator shall be connected with the press so that pressure on the head of the ram is registered by the pen arm on a vertical scale, and the distance rotated by the cylinder shall be proportional to the travel of the ram head.

11. Test Specimens. (a) Test specimens shall be one or two feet longer than the span between supports in the testing machine.

(b) Test specimens shall be cut from the crop of the top rail of the ingot, and marked on the center line of the top surface of the head with gage marks one inch apart for three inches each side of the center of the specimen, for measuring the ductility of the metal.

(c) Where it is necessary to test rails lower than the first rail, the bottom of the second rail, in lieu of the top of the third rail, will be accepted, if preferred by the manufacturer.

(d) The temperature of the test specimens shall be between 60 and 100 deg. F.

(e) Unless otherwise instructed by the purchaser, the test specimens shall be tested with the heads in tensions with the center punch marks midway between the supports.

12. Height of Drop. The test piece shall be subjected to impact of the tup falling free from the following heights:

For 70 to 79 lb. rail, incl..... 16 ft.

For 80 to 90 lb. rail, incl..... 17 ft.

For 91 to 110 lb. rail, incl..... 18 ft.

For 111 to 140 lb. rail, incl..... 20 ft.

13. Elongation. Under these impacts the rail under one or more blows shall show at least 8 per cent elongation for one inch of the six-inch scale, marked as described in Section 11 (b).

14. Exhausted Ductility Test. A sufficient number of blows shall be given to determine the complete elongation of the test piece of at least every fifth heat of Bessemer steel, and of one out of every three test pieces of a heat of open-hearth steel.

15. Permanent Set. For each specimen, a record shall be made of the permanent set, measured on a 3 ft. chord, after each blow under the drop test.

16. Test to Destruction. The test pieces which do not break under --

the first or subsequent blows shall be nicked and broken, to determine whether the interior metal is sound. The words "interior defect", ---- used below, shall be interpreted to mean seams, laminations, cavities or interposed foreign matter made visible by the destruction tests, the saws or the drills.

17. Bessemer Process Physical Tests. One piece shall be tested from -- each heat of Bessemer steel.

(a) If the test piece shows the required elongation (Section 13), -- all the rails of the heat shall be accepted, provided that the test -- piece when broken does not show interior defect.

(b) If the test piece does not show the required elongation (Sec-- tion 13), or if when broken shows interior defect, all of the top rails from that heat shall be rejected.

(c) A second test shall then be made of a test piece selected by -- the inspector from the top end of any second rail of the same heat, -- preferably of the same ingot. If the test piece shows the required --- elongation (Section 13), all of the remainder of the rails of the heat shall be accepted, provided that the test piece when broken does not -- show interior defect.

(d) If the test piece does not show the required elongation (Sec-- ton 13), or if when broken shows interior defect, all of the second -- rails from that heat shall be rejected.

(e) A third test shall then be made of a test piece selected by -- the inspector from the top end of any third rail of the same heat, pre-- ferably of the same ingot. If the test piece shows the required elon-- gation (Section 13), all of the remainder of the rails of the heat -- shall be accepted, provided that the test piece when broken does not -- show interior defect.

(f) If the test piece does not show the required elongation (Sec-- tion 13), or if when broken shows interior defect, all of the remain-- der of the rails from that heat shall be rejected.

18. Open-Heart Process Physical Tests. Test pieces shall be selected -- from the second, middle and last full ingot of each open hearth heat.

(a) If all these test pieces show the required elongation (Sec--- tion 13), all of the rails of the heat shall be accepted, provided --- that no test piece when broken shows interior defect.

(b) If any test piece does not show the required elongation (Sec-- tion 13), or if when broken shows interior defect, all of the top ---- rails from that heat shall be rejected.

(c) Second test shall then be made from three test pieces selected by the inspector from the top end of any second rails of the same heat preferably of the same ingots. If all these test pieces show the re--- quired elongation (Section 13), all of the remainder of the rails of -- the heat shall be accepted, provided that no test piece when broken --- shows interior defect.

(d) If any test piece does not show the required elongation (Sec-- tion 13), or if when broken shows interior defect, all of the second-- rails of the heat shall be rejected.

(e) Third tests shall then be made from three test pieces selected by the inspector from the top end of any third rails of the same heat, preferably of the same ingots. If all these test pieces show the requi-- red elongation (Section 13), all of the remainder of the rails of the-- heat shall be accepted, provided that no test piece, when broken, ---- shows interior defect.

(f) If any test piece does not show the required elongation (Sec-- tion 13), or if when broken shows interior defect, all of the remain-- der of the rails from the heat shall be rejected.

19. No 1 Rails. No 1 rails shall be free from injurious defects and -- flaws of all kinds.

20. No 2 Rails. Rails which vary from the specifications in a manner--

which does not impair their soundness and strength will be accepted as No 2 rails. The rails to be accepted are as follows:

(a) Rails arriving at the straightening process with sharp kinks or greater camber than that indicated by a middle ordinate of 4 in. in 33 ft. for the thick base sections, and 5 in. for the thin base sections.

(b) Rails which do not contain surface imperfections in such number or of such character as will, in the judgment of the inspector, render them unfit for recognized No 2 uses.

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 joint bars.

No 2 rails to the extent of 5 per cent of the whole order will be accepted.

DETAILS OF MANUFACTURE.

21. Quality of Manufacture. The entire process of manufacture shall be in accordance with the best current state of the art.

22. Record of Manufacture. When made a part of the contract, the manufacturer shall furnish the inspector with a carbon copy of open-hearth or Bessemer charge sheets; records of melting, tapping, ladle and teeming conditions; soaking pit charge sheets; rolling mill operation; rail weight sheets; hot bed and straightening records, wherever such sheets or records are in regular use by the manufacturer.

23. Bled Ingots. Bled ingots, from the center of which the liquid steel has been permitted to escape, shall not be used.

24. Discard. There shall be sheared from the end of the bloom, formed from the top of the ingot, sufficient metal to secure sound rails.

25. Lengths. The standard length of rails shall be 33 ft., at a temperature of 60 deg. Fahrenheit. Ten per cent of the entire order will be accepted in shorter lengths varying by 1 ft. from 32 to 25 ft. A variation of 1/4 in. from the specified lengths will be allowed, excepting that for 15 per cent of the order a variation of 3/8 in. from the specified lengths will be allowed. No 1 rails less than 33-ft. shall be painted green on both ends.

26. Stool Cutting. Care should be taken in teeming the ingots to prevent cutting out of the cast iron of the stools of ingot molds by the falling stream of hot metal from the ladle, and thus avoid a frequent cause of carbon streaks found in the finished rail.

27. Mold Spattering. Spattering the interior sides of the molds in pricking the heats or melts and teeming the ingots must be avoided as much as possible.

28. Stopper Defects. Excessive use of material thrown into the teeming ladle to set the stopper must be avoided.

29. Aluminum. The steel must be made to set quiet by the chemical composition in the molds without the addition of aluminum, either in the ladle or molds.

30. Time for Ingot Setting. Time must be allowed for the tops of the ingots to set without spraying with water.

31. Ingots Vertical. Ingots shall be kept in a vertical position on the ingot cars and in the reheating furnaces until their is equalized ready to be rolled.

32. Section. The section of rails shall conform as accurately as possible to the template 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 variation shall be allowed in the dimensions affecting the fit of the joint bars.

33. Weight. The weight of the rails specified in the order shall be maintained as nearly as possible, after complying with the preceding--

section. A variation of $1/2$ per cent from the calculated weight of section, as applied to the entire order, will be allowed.

34. Hot Bed Work and Straightening. (a) Care must be taken in cambering the rails and with the hot-bed work so that rails will cool with a small but uniform sweep, and therefore gagging under the presses--will be reduced to a minimum.

(b) Rails while on the cooling beds shall be protected from snow, water and excessive gusts of cold wind.

(c) When delivered to the straightening presses rails shall not vary in any direction from a straight line throughout their entire length more than 4 in. for the RE and RA thick base sections, and -- not more than 5 in. for ASCE sections.

(d) The supports for rails in the straightening presses shall have flat surfaces and be out of wind, and shall be spaced not less than 42 in. The application of the gag shall be central between ---- supports and the overhang of either end of the rail during straightening should be supported.

(e) Rails heard to snap while being straightened shall be at once rejected.

35. Drilling. Circular holes for joint bolts shall be drilled to conform to the drawings and dimensions furnished by the railroad company. A variation of $1/32$ in. in the size and location of bolt holes will be allowed.

36. Finishing. (a) All rails shall be smooth at the heads, straight in line and surface, and without any at-the-ends,--a-variation-of-not-more-than- $1/32$ -in.-being-allowed;--and-burrs-have-not-been-removed;--shall-be-rejected;--but-may-be-accepted-after-being-properly-finished. twists, waves or kinks. They shall be sawed square at the ends, a variation of not more than $1/32$ in. being allowed; and burrs shall be carefully removed.

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

(c) When any finished rail shows interior defects at either end or in any drilled hole, the entire rail shall be rejected.

37. Branding. Rails shall be branded for identification in the following manner:

(a) The name of the manufacturer, the month and year of manufacture, and the weight and type of section of rail shall be rolled in raised letters and figures on one side of the web. This type shall be marked by letters which signify the name by which it is known, as for example:

Engineers.....A. S. C. E.

Sections of American Railroad Association....R.A.A., R.A.-B.

Sections of American Railway Engineering Association.....R. E.

(b) The heat and ingot number as rolled and 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 joint bars. The top rails shall be lettered A, and the succeeding ---- ones B, C, D, etc., consecutively; but in case of a top discard of -- from 20 to 35 per cent, the letter B shall be omitted, the top rail becoming B. If the top discard be greater than 35 per cent, the ---- letter B shall be omitted, the top rail becoming C.

(c) Open-hearth rails shall be branded or stamped C-H in addition to other marks.

(d) All markings of rails shall be done so effectively that the marks may be read as long as the rails are in service.

38. Separate classes. All classes of rails shall be kept separate -- from each other.

39. Loading. Rails shall be carefully handled and loaded in such manner as not to injure them. When a part of the contract, all first quality rails of each heat shall be kept together in loading.

40. Payment. Rails accepted will be paid for according to actual weight

MATTERS SUBJECT TO CONTRACT.

Clause

Clause 3 - Steel may be Bessemer or open-hearth.

Clause 6c-Check analysis.

Facilities for analyses at the mill.

Clause 8 - The quick bend test.

Clause 22- Record of manufacture.

Clause 40- Loading.

Keeping rails of each heat together.

NOTES ON MANUFACTURE ADDED AS INFORMATION.

(To be attached to the specification).

Note A:

The selection of the ores, scrap, molten metal, fluxes and other furnace additions; regulation and quality of the port gases; condition of the slag, and time for refinement of each melt of steel require especial attention so that the molten steel when tapped will be refined and deoxidized.

Note B:

The steel must be well deoxidized and the waste products eliminated before the ingots are teemed, and thus prevent minute portions of the deoxidation products from becoming entrained in the setting metal. Time is required for the deoxidation products and impurities to rise after the steel is tapped into the ladle.

Note C:

Loose material and dirt should be removed from the ladle before tapping is commenced to prevent impurities from being incorporated in the molten metal. The ladle lining should be well set before tapping.

Attention should also be given to the proper coating of the ingot molds, and care should be taken to remove dirt or loose material from the tops of the ingot buggies before setting up the molds.

Note D:

The ingots should be stripped as soon as the metal caps over on top; weighed and charged promptly into the soaking pits, and thus avoid cooling of the interior metal. This checks the shrinkage of the steel, which may be large, depending upon the volume, chemical composition and temperature of the ingot at the time it is charged. The interior shrinkage can be confined to 0.05 to 0.1 per cent per cu. ft. of the metal, so that it is eliminated in the usual discard of the bloom, and helps to prevent piped rails due to cold ingots.

Note E:

The ingots should be uniformly heated in the soaking pits and the port gases properly regulated to prevent overheating, and with protection from direct impingement against the vertical faces of the ingots. The large hot ingots should be soaked at least two hours before blooming.

NOTE F:

Blooming the ingots and rolling the blooms into finished rails should all be done when the ranges of temperature for the ingots, blooms and rails are suitable for the metal to be cambered and then-cooled so that the transformations and recrystallization will be complete for the desired steel.

Notes-G:

Note G:

The hot rails from the saws and on the hot-beds should be spaced to allow the recalcence of the head to follow that of the base without being locked or blocked by adjacent rails on either side.

Note H:

The effect of straightening may be materially reduced for the heavier and stiffer sections by spacing the supports in the press at 60-in. centers. Several mills have made the necessary changes with beneficial results.

Care should be taken to see that the supports of the presses are not worn hollow, and the gags used have rounded corners, and are in good condition.

(Copied de Rail Bearing. TRACK SECTION.) Maintenance of way Cycloped_{1a}

(Section 4)

T A B L E :-

Constituent Elements	Bessemer Process (Limits per cent)		Open-Heart Process (Limits per cent)		
	Weight in lb., per yard.		Weight in lb., per yard.		
	70-84	85 and over	70-84	85-110	111 & over
Carbon.....	0.40 to 0.50	0.45 to 0.55	0.53 to 0.68	0.62 to 0.77	0.67 to 0.82
Phosphorus, not to ex- ceed.....	0.10	0.10	0.04	0.04	0.04
Manganese..	0.80 to 1.10	0.80 to 1.10	0.60 to 0.90	0.60 to 0.90	0.60 to 0.90
Silicon, not less than..	0.10	0.10	0.10	0.10	0.10