Designation: A1 – 00 (Reapproved 2018)

Standard Specification for Carbon Steel Tee Rails[1]

This standard is issued under the fixed designation A1; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers carbon steel tee rails of nominal weights of 60 lb/yd (29.8 kg/m) and over for use in railway track, including export and industrial applications.

1.2 Supplementary requirements S1 and S2 shall apply only when specified by the purchaser in the order.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A29/A29M Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought

A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment

E10 Test Method for Brinell Hardness of Metallic Materials

E127 Practice for Fabrication and Control of Aluminum Alloy Ultrasonic Standard Reference Blocks

E428 Practice for Fabrication and Control of Metal, Other than Aluminum, Reference Blocks Used in Ultrasonic Testing

2.2 *American Railway Engineering and Maintenance of Way Association (AREMA) Manual for Railway Engineering:* Specifications for Steel Rails Chapter 4, Part 2[3,4]

3. Ordering Information

3.1 Orders for rails under this specification shall include the following information:

3.1.1 ASTM designation and year of issue.

3.1.2 Type of rail desired.

3.1.3 Quantity (tons or pieces as appropriate).

3.1.4 Full identification of section with dimensional drawing, if required.

3.1.5 Arrangement of drilled bolt holes, if any, with dimensional drawing, if required.

3.1.6 Quantity of right-hand and left-hand (Note 1) drilled rails, drilled both-end rails, and undrilled (blank) rails desired.

3.1.7 Supplementary requirements that shall apply (see S1 and S2).

3.1.8 Disposition of various classifications of rails (see 8.3.6 and 8.3.7).

NOTE 1—The right-hand or left-hand end of the rail is determined by facing the side of the rail on which the brand (raised characters) appears.

4. Materials and Manufacture

4.1 *Rail Types*—Rails shall be furnished as-rolled (standard and alloy), head hardened (on-line or off-line processes), or fully heat treated as agreed upon between the purchaser and the manufacturer.

4.2 *Melting Practice*—The steel shall be made by any of the following processes: basic-oxygen or electric-furnace.

4.2.1 The steel shall be cast by a continuous process, in hot-topped ingots, or by other methods agreed upon between the purchaser and the manufacturer.

4.3 *Discard*—Sufficient discard shall be taken from the bloom or ingot to ensure freedom from injurious segregation and pipe.

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.01 on Steel Rails and Accessories.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Railway Engineering and Maintenance-of-Way Association (AREMA), 4501 Forbes Blvd., Suite 130, Lanham, MD 20706, https://www.arema.org.

[4] Adapted from AREMA Specifications for Steel Rails (see 2.2).

4.4 *Hydrogen Elimination:*

4.4.1 *Applicability:*

4.4.1.1 Rails 60 through 70 lb/yd (29.8 through 34.8 kg/m) are not subject to treatment for hydrogen elimination.

4.4.1.2 Rails over 70 through 84 lb/yd (over 34.8 through 41.7 kg/m) may be subjected to treatment for hydrogen elimination at the option of the manufacturer.

4.4.1.3 Rails over 84 lb/yd (41.7 kg/m) shall be processed by methods that prevent the formation of shatter cracks as agreed upon between the purchaser and the manufacturer.

4.4.2 Rail heats shall be tested for hydrogen content using either a sampling/analytical method or a direct measurement method of the liquid steel. The testing shall be performed either during the continuous casting process or during ingot teeming. Hydrogen content shall be recorded and available for review or reporting at the request of the purchaser. The producer shall define the method used to determine hydrogen content, which of the following methods are used for hydrogen removal, and present evidence of applicable procedures used to control the final rail hydrogen:

4.4.2.1 Vacuum degassing.

4.4.2.2 Bloom control cooling.

4.4.2.3 Rail control cooling.

4.4.3 *Rail Control-Cooling Procedure (AREMA Specifications for Steel Rails)*—Rails shall be control-cooled in accordance with the following procedure, except when produced from vacuum degassed steel or control-cooled blooms, in which case the rails may be air-cooled, and 4.4.3.1 – 4.4.3.5 are not applicable.

4.4.3.1 All rails shall be cooled on the hot beds or runways until full transformation is accomplished and then charged immediately into the containers. In no case should the rail be charged at a temperature below 725°F (385°C).

4.4.3.2 The temperature of the rails before charging shall be determined with a reliable calibrated pyrometer at the top of the rail head at least 12 in. (305 mm) from the end.

4.4.3.3 The cover shall be placed on the container immediately after completion of the charge and shall remain in place for at least 10 h. After removal or raising of the lid of the container, no rail shall be removed until the top layer of rails has fallen to 300°F (149°C) or lower.

4.4.3.4 The temperature between an outside rail and the adjacent rail in the bottom tier of the container at a point not less than 12 in. (305 mm) nor more than 36 in. (915 mm) from the rail end shall be recorded. This temperature shall be the control for judging rate of cooling.

4.4.3.5 The container shall be so protected and insulated that the control temperature shall not drop below 300°F (149°C) in 7 h for rails 100 lb/yd (49.7 kg/m) in weight or heavier, from the time that the bottom tier is placed in the container, and in 5 h for rails of less than 100 lb/yd in weight. If this cooling requirement is not met, the rails shall be considered control-cooled, provided that the temperature at a location not less than 12 in. (305 mm) from the end of a rail at approximately the center of the middle tier does not drop below 300°F in less than 15 h.

5. Chemical Composition

5.1 The chemical composition of the standard, head hardened, and fully heat treated rail steel, determined as prescribed in 5.2.1, shall be within the limits shown in Table 1. The chemical composition of alloy rail will be subject to agreement between the purchaser and the manufacturer.

5.1.1 When ladle tests are not available, finished material representing the heat may be product tested. The product analysis allowance beyond the limits of the specified ladle analysis shall be within the limits for product analyses specified in Table 2.

5.2 *Heat or Cast Analysis:*

5.2.1 Separate analysis shall be made from test samples representing one of the first three and one of the last three ingots or continuously cast blooms preferably taken during the pouring of the heat. Determinations may be made chemically or spectrographically. Any portion of the heat meeting the chemical analysis requirements of Table 1 may be applied. The analysis, most representative of the heat (clear of the transition zone for continuous cast steel), shall be recorded as the official analysis, but the purchaser shall have access to all chemical analysis determinations. Additionally, any material meeting the product analysis limits shown in Table 2 may be applied after testing such material in accordance with Specification A29/A29M.

5.2.2 Upon request by the purchaser, samples shall be furnished to verify the analysis as determined in 5.2.1.

6. Interior Condition

6.1 For both ingot steel and continuously cast steel, between macroetch testing shall be performed as agreed upon between the purchaser and the manufacturer.

6.2 *Macroetch Testing*—Rail soundness shall be evaluated by macroetching in a hot acid solution.

6.2.1 *Sample Location and Frequency:*

6.2.1.1 *Ingot Steel*—A test piece representing the top end of the top rail from one of the first three, middle three, and last three ingots of each heat shall be macroetched.

6.2.1.2 *Continuous Cast Steel*—A test piece shall be macroetched representing a rail from each strand from the beginning of each sequence and whenever a new ladle is begun, which is the point representative of the lowest level in the tundish (that is, the point of lowest ferrostatic pressure). One

TABLE 1 Chemical Requirements—Heat Analysis

Element	Nominal Weight, lb/yd (kg/m)		
	60 to 84 (29.8 to 41.7), incl	85 to 114 (42.2 to 56.6), incl	115 (57.0) and over
Carbon	0.55 to 0.68	0.70 to 0.80	0.74 to 0.84
Manganese	0.60 to 0.90	0.70 to 1.00	0.80 to 1.10[A]
Phosphorus, max	0.040	0.035	0.035
Sulfur, max	0.050	0.040	0.040
Silicon	0.10 to 0.50	0.10 to 0.50	0.10 to 0.50

[A] The upper manganese limit may be extended to 1.25 % by the manufacturer to meet the Brinell hardness specification. When manganese exceeds 1.10 %, the residual alloy contents will be held to 0.25 % maximum nickel; 0.25 % maximum chromium; 0.10 % maximum molybdenum; and 0.03 % maximum vanadium.

TABLE 2 Product Analysis Allowance Beyond Limits of Specified Chemical Analysis

	Percent Under Minimum Limit	Percent Over Maximum Limit
Carbon	0.04	0.04
Manganese	0.06	0.06
Phosphorus	. . .	0.008
Sulfur	. . .	0.008
Silicon	0.02	0.02[A]

[A] Continuously cast allowances shall be 0.05 % over maximum limit for silicon.

TABLE 3 Hardness Requirements of Standard Carbon Rails

	Nominal Weight, lb/yd (kg/m)		
	60 to 84 (29.8 to 41.7), incl	85 to 114 (42.2 to 56.6), incl	115 (57.0) and over
Brinell Hardness, min	201	285	300

TABLE 4 Hardness Requirements of High-Strength Rails (See notes)

NOTE 1—Hardness specified in Table 4 pertain to the head area only.

NOTE 2—A fully pearlitic microstructure shall be maintained in the head.

NOTE 3—If 410 HB is exceeded, the microstructure throughout the head shall be examined at 100× or higher for confirmation of a fully pearlitic microstructure in the head.

NOTE 4—No untempered martensite shall be present within the rail.

	Nominal Weight, lb/yd (kg/m)		
	60 to 84 (29.8 to 41.7), incl	85 to 114 (42.2 to 56.6), incl	115 (57.0) and over
Brinell Hardness	277 to 341	321, min	341, min

additional sample from the end of each strand of the last heat in the sequence shall also be tested. A new tundish is considered to be the beginning of a new sequence.

6.2.2 If any test specimen does not conform to the acceptable macroetch pictorial standards agreed upon between the purchaser and the manufacturer, further samples shall be taken from the same strand or ingot. For continuously cast steel, two retests shall be taken one from each side of the original sample at positions decided by the manufacturer, and the material between the two retest positions shall be rejected. For ingot steel, testing shall progress down the ingot. If any retest fails, testing shall continue until acceptable internal quality is exhibited. All rails represented by failed tests shall be rejected.

7. Hardness Properties

7.1 Rails shall be produced as specified by the purchaser within the limits found in Table 3 and Table 4,

7.2 The Brinell hardness test shall be performed on a rail, a piece of rail at least 6 in. (152 mm) long cut from a rail of each heat of steel or heat-treatment lot, or from a ground/milled transverse sample cut from the 6-in. piece. The test shall be made on the side or top of the rail head after decarburized material has been removed to permit an accurate determination of hardness. Alternately, the test may be made on the prepared transverse ground/milled sample ⅜ in. from the top rail surface.

7.3 The test shall otherwise be conducted in accordance with Test Method E10.

7.4 If any test result fails to meet the specifications, two additional checks shall be made on the same piece. If both checks meet the specified hardness, the heat or heat treatment lot meets the hardness requirement. If either of the additional checks fails, two additional rails in the heat or lot shall be checked. Both of these checks must be satisfactory for the heat or lot to be accepted. If any one of these two checks fails, individual rails may be tested for acceptance.

7.5 If the results for off-line head hardened rails and fully heat treated rails fail to meet the requirements of 7.1, the rails may be retreated at the option of the manufacturer, and such rails shall be retested in accordance with 7.2 and 7.3.

8. Permissible Variations of Dimension, Weight, and Other Physical Attributes

8.1 *Section:*

8.1.1 The section of the rail shall conform to the design specified by the purchaser.

8.1.2 A variation of 0.015 in. (0.38 mm) less or 0.040 in. (1.02 mm) greater than the specified height will be permitted measured at least 1 in. (25.4 mm) from each end.

8.1.3 A variation of 0.030 in. (0.76 mm) less or 0.030 in. greater than the specified rail head width will be permitted measured at least 1 in. (25.4 mm) from each end.

8.1.4 A variation of 0.050 in. (1.27 mm) in the total width of the base will be permitted.

8.1.5 No variation will be allowed in dimensions affecting the fit of the joint bars, except that the fishing template approved by the purchaser may stand out laterally not more than 0.060 in. (1.5 mm) when measured within the 18-in. (460-mm) end locations.

8.1.6 A variation of 0.060 in. (1.5 mm) in the asymmetry of the head with respect to the base will be permitted.

8.1.7 A variation of 0.020 in. (0.51 mm) less or 0.040 in. (1.02 mm) greater than the specified thickness of web will be permitted.

8.1.8 Verification of tolerances shall be made using appropriate gages as agreed upon between the purchaser and the manufacturer.

8.2 *Length:*

8.2.1 The standard length of rails shall be 39 ft (11.9 m) or 80 ft (24.4 m), or both, when measured at a temperature of 60°F (15°C).

8.2.2 Up to 9 % for 39 ft rail or 15 % for 80 ft rail of the entire order will be accepted in lengths shorter than the standard, varying by 1 ft (0.3 m) as follows: 79, 78, 77, 75, 70, 65, 60, 39, 38, 37, 36, 33, 30, 27, and 25 ft.

8.2.3 A variation of 7⁄16 in. (11 mm) for 39-ft (11.9-m) rails or ⅞ in. (22 mm) for 80-ft rails (24.4-m) will be permitted.

8.2.4 Length variations other than those specified in 8.2.2 and 8.2.3 may be established by agreement between the purchaser and the manufacturer.