



Designation: A 583 – 93 (Reapproved 1999)

Standard Specification for Cast Steel Wheels for Railway Service¹

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1. Scope

1.1 This specification covers one-wear, two-wear, and multiple-wear cast carbon steel wheels for use on locomotives and cars, designated Class U, untreated, and Classes L, A, B, and C, heat-treated wheels.

1.2 The service for which the various classes are intended is as follows:

1.2.1 Class B or C wheels shall be used for freight cars in interchange service.

1.2.2 Class B or C wheels are recommended for use on locomotives.

1.2.3 For passenger car service, the various classes are intended generally as follows:

1.2.3.1 *Class L*—High speed with more severe braking conditions than other classes and light wheel loads.

1.2.3.2 *Class A*—High speed service with severe braking conditions, but moderate wheel loads.

1.2.3.3 *Class B*—High speed service with severe braking conditions and heavier wheel loads.

1.2.3.4 *Class C*—(1) Service with light braking conditions and heavier wheel loads.

1.2.3.5 *Class C*—(2) Service with heavier braking conditions where off-tread brakes are employed.

1.2.4 *Class U*—Wheels may be used in service in which the wheel load and braking are low.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

¹ This specification is under the jurisdiction of Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.18 on Castings

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E 59 Practice for Sampling Steel and Iron for Determination of Chemical Composition²

E 350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron²

E 415 Test Method for Optical Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel³

E 1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys³

2.2 AAR Standard:

AAR Wheel and Axle Manual, Section G-M-208⁴

2.3 SAE Documents:

J442 Standard for Test Strip, Holder and Gage for Shot Peening⁵

J443 Recommended Practice for Procedures for Using Standard Shot Peening Test Strip⁵

J827 Recommended Practice for Cast Steel Shot⁵

2.4 Military Standard:

MIL-S-13165B Shot Peening of Metal Parts⁶

3. Ordering Information

3.1 The inquiry, order, or contract for material under this specification shall include:

3.1.1 Quantity (number of pieces),

3.1.2 Class (see Section 1),

3.1.3 Full identification of wheel design, including tread and flange contour, and dimensional drawing if required,

3.1.4 Rough bore size,

3.1.5 Intended service (see Section 1),

3.1.6 ASTM designation and year of issue, and

3.1.7 Supplementary requirements (if any).

² Annual Book of ASTM Standards, Vol 03.05.

³ Annual Book of ASTM Standards, Vol 03.06.

⁴ Available from the Association of American Railroads, 50 F St. N.W., Washington, DC 20001.

⁵ Available from the Society of Automotive Engineers, Inc., 400 Commonwealth Dr., Warrendale, PA 15906.

⁶ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.



4. Manufacture

4.1 *Melting Practice*—The steel shall be melted in electric furnaces.

4.2 *Temperatures*—During the processes of manufacture, necessary care in regulation of temperature gradients shall be exercised to obtain the mechanical properties to be expected from the chemical composition and to prevent the development of internal discontinuities and injurious stresses.

4.3 Heat Treatment:

4.3.1 For Class L, A, B, and C wheels, the heat treatment shall consist of treatment of the rim only.

4.3.2 *Rim-Quenching Treatment*—The wheels shall be uniformly reheated to the proper temperature to refine the grain and then the rims shall be quenched. Following quenching, the wheel shall be charged into the furnace for tempering to meet the mechanical requirements described in Section 7, and subsequently cooled under controlled conditions.

5. Shot Peening

5.1 The plate surfaces of all wheels shall be shot-peened in accordance with the following requirements:

5.1.1 *Shot*—The shot shall be SAE No. 550 or larger hardened steel, as specified in SAE Recommended Practice J827.

5.1.2 *Shot Size Control*—The peening machines shall be equipped with a separator for continuously removing broken shot. Sufficient new shot shall be added to ensure that a minimum of 85 % of SAE No. 550 or larger shot is maintained in the machine at all times.

5.1.3 *Peening Intensity*—The peening intensity shall be sufficient to produce an average arc height of not less than 0.008 (0.20 mm) C Standard Almen gage No. 2 on the front plate near the hub fillet and on the back plate near the rim fillet of wheels of the standard design and at the back plate hub fillet and front plate rim fillet of the reverse plate design.

5.1.3.1 *Arc Height Measurement*—Measurement of arc height shall be made in accordance with SAE Standard J442 and SAE Recommended Practice J443.

5.1.4 *Coverage*—The minimum peening time shall be sufficient to ensure that full coverage is attained on the Almen C-2 strip as defined in the alternative procedure of SAE Recommended Practice J443, or 6.11 of Military Standard MIL-S-13165B.

5.1.5 *Sequence*—Shot peening shall be performed on all wheels and after any corrective surface preparation in the plate area.

5.1.6 Quality Assurance Provisions:

5.1.6.1 *Wheel Surface Condition*—The peened appearance of rim and hub shall not be cause for rejection.

5.1.6.2 *Frequency of Test*—Arc height determinations shall be made on Almen strips attached to a test wheel at the beginning and end of each production run, but not less than once in each 8-hour operating period.

5.1.6.3 *Retest*—If a test fails to meet the arc height requirement of 0.008 (0.20 mm) C Standard Almen gage No. 2, two retests shall be made. These retests shall be averaged with the

first determination. The average shall be not less than 0.008 and no more than one value of the three shall be less than 0.008.

5.1.6.4 *Repeening*—When test values fail to meet the provisions of 5.1.6.3, corrective action shall be initiated and satisfactory test values secured before proceeding with production peening. If the average Almen value of the unsatisfactory test is 0.006 or 0.007 (0.16 or 0.19 mm), the last half of the wheels peened prior to the unsatisfactory test, but subsequent to a satisfactory test, shall be repeened with at least one-half exposure time. If the average Almen value is less than 0.006, all of the wheels peened since the last satisfactory test shall be repeened with full exposure.

6. Chemical Composition

6.1 The steel shall conform to the requirements of Table 1 as to chemical composition.

6.2 *Heat Analysis*—An analysis of each heat of steel shall be made by the manufacturer to determine the percentage of the elements specified in Table 1. This analysis shall be made on a test specimen taken during the pouring of the heat. The chemical composition thus determined, together with such identifying records as may be desired, shall be reported to the purchaser or the purchaser's representative, and shall conform to the requirements specified in Table 1.

6.3 *Product Analysis*—An analysis may be made by the purchaser from a sample furnished by the manufacturer representing the day's heats, or from finished wheels selected from heats in question by the purchaser's representative. The chemical composition thus determined shall conform to the requirements specified in Table 1 with a permissible carbon variation of -0.02 or $+0.03$ percentage points. Samples from a finished wheel shall be obtained at a location in the hub in such a manner as not to impair the usefulness of the wheel. No drilling of the finished wheel shall be permitted for chemical analysis. Each sample shall be thoroughly mixed together and shall be clean and free of scale, oil, and other foreign substances.

6.4 *Alternate Sampling Method*—When wheel blocks are not available for chemical analysis, the laboratory conducting the chemical analysis shall follow a standard sampling method in accordance with Practice E 59.

6.5 *Chemical Analysis Method*—Chemical analysis shall proceed as described in 6.5.1 or 6.5.2. All analyses should note which method is used for the carbon or chemical determinations, or both.

6.5.1 *Test Method I*—Apply one of the procedures in 6.5.1.1 through 6.5.1.3 to make the carbon determinations:

TABLE 1 Chemical Requirements

Composition, %	
Carbon:	
Class U	0.65 to 0.77
Class L, max	0.47
Class A	0.47 to 0.57
Class B	0.57 to 0.67
Class C	0.67 to 0.77
Manganese	0.60 to 0.85
Phosphorus, max	0.05
Sulfur, max	0.05
Silicon, min	0.15



6.5.1.1 Total carbon by the Combustion Gravimetric Method, Test Method E 350,

6.5.1.2 Total carbon by the Combustion Thermal Conductivity Method, Test Methods E 1019, or

6.5.1.3 Total carbon by Combustion, followed by quantitative infrared analysis, Test Methods E 1019, or report standardization method used.

6.5.2 *Test Method II*—Apply the procedures in Test Method E 415 to make the carbon determinations.

7. Mechanical Properties

7.1 Hardness Tests:

7.1.1 *Requirements*—The hardness of the rim, when measured in accordance with the requirements of the following section, shall show the value prescribed in Table 2.

7.1.2 *Number of Tests*—Where continuous heat-treating furnaces are used in connection with Class L, A, B, and C wheels, Brinell hardness measurements shall be made on 10 % of the wheels from each heat. Where batch-type, heat-treating furnaces are used, Brinell hardness measurements shall be made on 10 % of the wheels from each heat-treatment lot, provided that at least one wheel is selected for test from each heat represented in the heat-treatment lot. For either process, when there are less than 20 wheels from a heat, a minimum of two wheels shall be checked for hardness except when there is only one wheel from a heat, in which case a Brinell hardness measurement shall be made on the one wheel.

7.1.2.1 If all the wheels tested meet the requirements of 7.1.1, all of the wheels represented shall be accepted.

7.1.2.2 If any wheel tested fails to meet the requirements of 7.1.1, it shall be checked by making two additional hardness measurements, one on each side of the point first measured, and each approximately 1 in. (25.4 mm) from that point. If both of these check measurements meet the requirements of 7.1.1, the wheel shall be considered to have met the requirements of that section.

7.1.2.3 When continuous heat-treating furnaces are used, and if any of the wheels tested fail on check to meet the requirements of 7.1.1, the manufacturer may test, for individual hardness measurements, all of the wheels of that heat in the lot submitted for inspection, and those meeting the requirements of 7.1.1 shall be accepted. When batch heat-treating furnaces are used, and if any of the wheels tested fail on check test to meet the requirements of 7.1.1, the manufacturer may test all of the wheels in the heat-treatment lot for individual hardness measurement and those meeting the requirements of 7.1.1 shall be accepted.

7.1.3 *Test Locations and Orientation*—The Brinell test shall be made on the front face of the rim with the edge of the impression not less than $\frac{3}{16}$ in. (4.8 mm) from the radius

joining the face and the tread. Before making the impression, any decarburized metal shall be removed from the front face of the rim at the point selected for measurement. The surface of the wheel rim shall be properly prepared to permit accurate determination of hardness.

8. Nondestructive Testing

8.1 Magnetic Particle Test:

8.1.1 *Scope*—This test covers the wet fluorescent magnetic particle inspection of the plates of wheels ordered to this specification.

8.1.2 *Purpose*—To supplement visual inspection of the surface of new wheels by detecting discontinuities that may be harmful to wheel service.

8.1.3 Equipment:

8.1.3.1 *Magnetizing Apparatus*—The magnetizing apparatus shall be capable of inducing suitable magnetic fields within the entire plate area of the wheel to facilitate the disclosure of both circumferentially- and radially-oriented discontinuities. The magnetizing currents used shall be large enough to induce fields of sufficient intensity to disclose surface discontinuities exceeding 0.015 in. (0.38 mm) in depth and $\frac{1}{4}$ in. (6.35 mm) long. The use of prod-type contacts is prohibited.

8.1.3.2 *Lighting Apparatus*—The inspection shall be performed in a darkened booth with the areas of the wheel to be inspected illuminated with properly filtered black light. The black light shall have a predominant wavelength of 400 to 340 nm and the intensity of the black light, measured at the surface to be inspected, shall be a minimum of 75 fc (807 lx).

8.1.3.3 *Testing Medium*—The bath or solution should be prepared, using a suitable carrier fluid and fluorescent magnetic particles, and renewed monthly or more frequently, if contamination is noted in weekly tests. Each time the bath is renewed, the bath container should be cleaned and the agitation and circulation system should be flushed with 1 or 2 gal of clean carrier. Filtering screens should be removed and cleaned by blowing with air. In preparing the new bath, only recommended materials should be used. The amount of powder should be carefully weighed out in accordance with the material manufacturer's recommendation, and the powder should be added directly to the bath containing the correct amount of carrier. It is recommended that powder be added directly over the sump so that it will be drawn quickly into the pump and circulated. The amount of carrier and powder used and the date of preparation should be recorded on a regular form set up for this purpose as outlined in Paragraph (e).

(a) Concentration and contamination of the bath solution should be tested weekly as follows: Pump and agitation system should be circulated for 20 min, and then solution should be run through hose and nozzle for 30 s. Using a regular 100-mL centrifuge tube, fill the centrifuge tube with 100 mL of the solution. Allow bath solution to settle for the time recommended by the manufacturer of the type of powder used ensuring that the tube is not subjected to excessive vibration during the settling period. Each horizontal division represents 0.1 mL, and correct readings in volume of particles must be as stipulated by the powder manufacturer. Ensure that contamination does not occur from dirt, chips, or other foreign matter settling with the powder. Contamination is indicated by the

TABLE 2 Rim Hardness Values

Class	Brinell Hardness, HB	
	min	max
L	197	277
A	255	321
B	277	341
C	321	363