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Standard Specification for Wrought Steel Wheels for Electric Railway Service¹

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1. Scope

1.1 This specification covers wrought steel wheels for electric railway service designated Class U, untreated, and Classes L, A, B, and C, heat treated.

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

1.2.1 *Class U*—General service where an untreated wheel is satisfactory.

1.2.2 *Class L*—High-speed service with more severe braking conditions and light wheel loads.

1.2.3 *Class A*—High-speed service with heavy braking conditions, but with moderate wheel loads.

1.2.4 *Class B*—High-speed service with heavy braking conditions and heavier wheel loads.

1.2.5 *Class C*—Service with light braking conditions and high wheel loads, or service with heavier braking conditions where off-tread brakes are employed.

NOTE 1—The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 ASTM Standards:

A 370 Methods and Definitions for Mechanical Testing of Steel Products²

E 59 Method of Sampling Steel and Iron for Determination of Chemical Composition³

E 350 Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron³

E 415 Method for Optical Emission Vacuum Spectrometric Analysis of Carbon and Low-Alloy Steel⁴

NOTE 2—References to analysis standards are for guidance only; other methods of equivalent accuracy may be used.

2.2 SAE Documents:

SAE J442 Test Strip, Holder and Gage for Shot Peening⁵

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

SAE J827 Recommended Practice for Cast Steel Shot⁵

2.3 Military Standard:

MIL-S-13165B Shot Peening of Metal Parts⁶

2.4 *AAR Standard:*

AAR Wheel and Axle Manual⁷

3. Ordering Information

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

3.1.1 Quantity,

3.1.2 Class,

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, and

3.1.6 ASTM designation and date of issue.

4. Manufacture

4.1 Melting Process:

4.1.1 The steel shall be made by one or more of the following processes: open-hearth, basic-oxygen, or electric-furnace.

4.1.2 A sufficient discard shall be made from each ingot to ensure freedom from injurious piping and undue segregation.

4.2 *Hot-Working Procedure*—During the processes of manufacture, necessary care in the regulation of temperature gradients shall be exercised to obtain the mechanical properties to be expected from the chemical composition and mechanical work, and to prevent the development of faulty structure. All wheels, immediately after the last hot-fabricating operation (coning or dishing), shall be allowed to cool to a temperature below the critical range. The cooling shall be controlled to prevent injury by too rapid cooling below the critical range.

4.3 *Heat Treatment*—For Classes L, A, B, or C, the heat treatment shall consist of heat treatment of the rim only.

4.3.1 *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 wheels shall be charged into a furnace for tempering to meet the requirements of 6.1.1 and subsequently cooled under controlled conditions.

4.4 *Shot Peening*—The plate surfaces of all wheels shall be shot peened in accordance with the following requirements:

4.4.1 The shot shall be SAE No. 550 or larger hardened steel, as specified in SAE Recommended Practice J827.

4.4.2 *Shot Size Control*—The peening machine shall be

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² Annual Book of ASTM Standards, Vol 01.04.

³ Annual Book of ASTM Standards, Vol 03.05.

⁴ Annual Book of ASTM Standards, Vol 03.06.

⁵ Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

⁶ Available from Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120.

⁷ Available from Association of American Railroads, 50 "F" St., N.W., Washington, DC 20001.



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A 25

TABLE 1 Chemical Requirements

Element	Composition, %
Carbon	
Class U	0.65 to 0.77
Class L	not over 0.47
Class A	0.47 to 0.57
Class B	0.57 to 0.67
Class C	0.67 to 0.77
Manganese	0.80 to 0.85
Phosphorus	0.05 max
Sulfur	0.05 max
Silicon	0.15 min

equipped with a separator for continuously removing broken shot. Sufficient new shot shall be added to ensure that a minimum of 85 % of No. 550 or larger shot is maintained in the machines at all times.

4.4.3 *Peening Intensity* shall be sufficient to produce an average arc height of not less than 0.008 Almen C-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 back plate hub fillet and front plate rim fillet of reverse plate design. The area to be peened is defined as the plate area extended approximately one-half the way into the hub and rim fillet radii on the front and on the back of the wheel.

4.4.3.1 *Arc Height Measurement* shall be made in accordance with SAE Standard J442 and SAE Recommended Practice J443.

4.4.4 *Coverage*—The minimum peening time shall be sufficient to ensure full coverage on the Almen C strip as defined in SAE Recommended Practice J443, alternative procedure, or MIL-S-13165B, Paragraph 6.11.

4.4.5 *Sequence*—Shot peening shall be performed on all wheels and after any corrective surface preparation in the plate area. Plate area is defined in 4.4.3. Peening may be performed prior to inspection.

4.4.6 *Portable Peeners*—A portable device may be used to re-peen small reconditioned areas (no larger than about 2 by 3 in.) on wheel plate surfaces excluding the critical fillet areas (front hub and back rim). The portable equipment must be capable of peening an Almen C-2 Strip to develop the required average arc height of not less than 0.008 in. with a reasonable time of peening. Peening time of wheel plates must be at least as long as the time required to develop the 0.008 in. arc height. The equipment must be tested on an Almen C Strip each 8 h shift that the portable peener is used. A record of the Almen C test results shall be maintained.

4.4.7 *Quality Assurance:*

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

4.4.7.2 *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 operating-hour period.

4.4.7.3 *Retest*—If a test fails to meet the arc height requirements of 0.008 Almen C, 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.

4.4.7.4 *Repeening*—When test values fail to meet the provisions of 4.4.7.3, corrective action shall be initiated and satisfactory test values secured before proceeding with pro-

TABLE 2 Rim Hardness Values

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

^A No requirement.

duction peening. If the average Almen value of the unsatisfactory test is 0.006 or 0.007, the last half of the wheels peened prior to the unsatisfactory test, but subsequent to a satisfactory test, shall be repeened with at least half exposure time. If the average Almen value is less than 0.006, all wheels peened since the last satisfactory test shall be repeened with full exposure.

5. Chemical Requirements

5.1 *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 from 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 his representative, and shall conform to the requirements specified in Table 1.

5.2 *Chemical Analysis*—Chemical analysis of each heat of steel shall be made by one of the following test methods. All analyses should note which test method is used for the carbon or chemical determinations, or both.

5.2.1 *Test Method*—Using Methods E 350, determine total carbon by (1) the Combustion Gravimetric Method, or (2) the Combustion Thermal Conductivity Method.

5.2.2 *Test Method II*—Use Method E 415.

5.3 *Product Analysis*—An analysis may be made by the purchaser from a wheel block or from a finished wheel selected from each heat by the purchaser's representative. The chemical composition, determined in accordance with Methods E 350 or E 415, shall conform to the requirements specified in Table 1 with a permissible carbon variation of -0.02 or $+0.03$ %. Samples from wheel blocks shall be drilled from the end of the block midway between the center and the outside. When a finished wheel is used, the sample shall be obtained from the rim face or the hub in a manner that will not impair the usefulness of the wheel. No drilling of the finished wheel plate shall be permitted. Each sample from any one block or wheel shall be thoroughly mixed together, and shall be clean and free from scale, oil, and other foreign substances.

5.4 *Sampling Method*—When wheel blocks or when whole wheels are not available for chemical analysis, the laboratory conducting the chemical analysis shall follow a standard sampling method. This standard method of sampling shall be Method E 59, used in conjunction with Methods E 350 or E 415 for chemical analysis (see 5.2).

6. Mechanical Requirements

6.1 *Hardness Tests:*

6.1.1 *Requirements*—The hardness of the rim, when measured in accordance with Methods and Definitions A 370



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