



## Designation: A504/A504M – 18 (Reapproved 2023)

# Standard Specification for Wrought Carbon Steel Wheels<sup>1</sup>

This standard is issued under the fixed designation A504/A504M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers one-wear, two-wear, and multiple-wear wrought carbon steel wheels for locomotives and cars, designated 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 with more 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.

1.3 Supplemental requirements are provided for use where additional testing or additional restrictions are required by the purchaser. Supplementary requirements included in Specification A788/A788M may also be specified by the purchaser for forgings ordered to this specification. Any supplemental requirements apply only when specified in the purchase order.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text and tables, the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.06 on Steel Forgings and Billets.

Current edition approved March 15, 2023. Published April 2023. Originally approved in 1964 to replace A57 and A186. Last previous edition approved in 2018 as A504/A504M – 18. DOI: 10.1520/A0504\_A0504M-18R23.

1.5 Unless the order specifies the applicable “M” specification designation, the material shall be furnished to the inch-pound units.

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

1.7 *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:<sup>2</sup>

A275/A275M Practice for Magnetic Particle Examination of Steel Forgings

A388/A388M Practice for Ultrasonic Examination of Steel Forgings

A788/A788M Specification for Steel Forgings, General Requirements

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E399 Test Method for Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials

### 2.2 SAE Documents:<sup>3</sup>

SAE J 442 Test Strip, Holder and Gage for Shot Peening

SAE J 443 Recommended Practice for Procedures for Using Standard Shot Peening Test Strip

SAE J 827 Recommended Practice for Cast Steel Shot

SAE J 2277 Shot Peening Coverage Determination

### 2.3 AAR Standard:<sup>4</sup>

AAR M-107/M-208 Wheels, Carbon Steel

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

<sup>3</sup> Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, <http://www.sae.org>.

<sup>4</sup> Available from Association of American Railroads (AAR), 425 Third Street, SW, Washington, DC 20024, <http://www.aar.org>.

### 3. Terminology

3.1 *Definitions*—(The following terminology is unique to the Railroad industry).

3.1.1 *multi-wear wheel, n*—wheel that has sufficient metal in the rim for more than two turnings before it must be replaced.

3.1.2 *one wear wheel, n*—wheel that has only sufficient metal for the tread to be worn once to condemnable high flange or thin rim condition.

3.1.2.1 *Discussion*—There is insufficient metal remaining in the rim to allow turning or truing of the wheel by machining to the standard tread contour and still have enough metal in the rim to support service loads. Wear refers to the amount of metal on the wheel rim when new, in excess of the condemning thickness of the wheel design.

3.1.3 *tape size, n*—railroad method of expressing wheel circumference based on measurement with a steel tape placed around the tread at the taping line.

3.1.3.1 *Discussion*—For each wheel size there is a calibrated tape. Tape size is expressed as the number of one-eighth increments in circumference from the standard tape for the wheel being measured. An AAR approved tape has four lugs to correctly space the tape from the rim so that the tape will measure on the taping line. The tapeline is always  $1\frac{1}{16}$  in. from the gage point, which is how the tape gage was designed. Some wheel profiles define the tapeline as  $3\frac{1}{16}$  in. from the back rim face; this may not be correct.

3.1.4 *two-wear wheel, n*—wheel that has more metal in the rim than a one-wear wheel so that the tread can be worn to condemnable condition and then be restored by machining to the original tread contour. Thus, two tread wear lives are obtained from this wheel.

### 4. Ordering Information and General Requirements

4.1 Material supplied to this specification shall conform to the requirements of Specification **A788/A788M**, which outlines basic ordering information, manufacturing requirements, testing and retesting methods, marking, certification, product analysis variations, and additional supplementary requirements.

4.1.1 If the requirements of this specification are in conflict with the requirements of Specification **A788/A788M**, the requirements of this specification shall prevail.

4.2 Orders for wheels under this specification shall include the following additional information as appropriate:

4.2.1 Class (see **Table 1**),

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

4.2.3 Rough bore size,

4.2.4 Wear category,

4.2.5 Alternate magnetic particle acceptance criteria (**15.2.3.2**),

4.2.6 Intended service (see **Section 1**),

4.2.7 Supplementary requirements from this specification, if required, and

4.2.8 Supplementary requirements from Specification **A788/A788M**, if required.

### 5. Chemical Requirements

5.1 *Heat Analysis*:

5.1.1 The steel shall conform to the requirements for chemical composition shown in **Table 1**.

### 6. Manufacture

6.1 *Discard*—Sufficient discard shall be made from each ingot to ensure freedom from piping and undue segregation.

6.2 *Temperatures*—During the 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. Immediately after the last hot fabricating operation (coning or dishing), all wheels shall be allowed to cool to a temperature below the critical range. The cooling shall be controlled to prevent injury by too rapid cooling.

### 7. Heat Treatment

7.1 Heat treatment shall consist of treatment of the rim only.

7.2 *Rim-Quenching Treatment*—The entire wheel shall be reheated uniformly to the proper temperature to refine the grain

**TABLE 1 Chemical Requirements**

| Element %                             | Class L     | Class A     | Class B     | Class C     |
|---------------------------------------|-------------|-------------|-------------|-------------|
| Carbon                                | 0.47 max    | 0.47–0.57   | 0.57–0.67   | 0.67–0.77   |
| Manganese                             | 0.60–0.90   | 0.60–0.90   | 0.60–0.90   | 0.60–0.90   |
| Phosphorous, max                      | 0.030       | 0.030       | 0.030       | 0.030       |
| Sulfur                                | 0.005–0.040 | 0.005–0.040 | 0.005–0.040 | 0.005–0.040 |
| Silicon                               | 0.15–1.00   | 0.15–1.00   | 0.15–1.00   | 0.15–1.00   |
| Nickel, max <sup>A</sup>              | 0.25        | 0.25        | 0.25        | 0.25        |
| Chromium, max <sup>A</sup>            | 0.25        | 0.25        | 0.25        | 0.25        |
| Molybdenum, max <sup>A</sup>          | 0.10        | 0.10        | 0.10        | 0.10        |
| Vanadium, max <sup>A</sup>            | 0.060       | 0.060       | 0.060       | 0.060       |
| Copper, max                           | 0.35        | 0.35        | 0.35        | 0.35        |
| Aluminum, max                         | 0.060       | 0.060       | 0.060       | 0.060       |
| Titanium, max                         | 0.03        | 0.03        | 0.03        | 0.03        |
| Columbium, max (Niobium) <sup>B</sup> | 0.05        | 0.05        | 0.05        | 0.05        |

<sup>A</sup> The manufacturer may exceed the noted maximum limits for nickel, chromium, molybdenum, or vanadium provided that the following relationship (AAR M-107/M-208) is met:

$$930 - [570 \times \%C] - [80 \times \%Mn] - [20 \times \%Si] - [50 \times \%Cr] - [30 \times \%Ni] - [20 \times (\%Mo + \%V)] > 390$$

<sup>B</sup> Columbium (Cb) and Niobium (Nb) are alternate names for Element 41 in the Periodic Table of the Elements.