



Designation: A638/A638M – 20

# Standard Specification for Precipitation Hardening Iron Base Superalloy Bars, Forgings, and Forging Stock for High-Temperature Service<sup>1</sup>

This standard is issued under the fixed designation A638/A638M; 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<sup>2</sup> covers hot-finished or cold-finished precipitation hardening iron base superalloy bars, forgings, and forging stock for high-temperature service. The mechanical properties of these alloys are developed by suitable solution treating and precipitation hardening treatments.

1.2 Two grades of iron base alloy are covered. Selection will depend upon design, service conditions, mechanical properties, and elevated temperature characteristics.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. SI units are shown in brackets. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4 Unless the order specifies an “M” designation, the material shall be furnished to inch-pound units.

1.5 *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>3</sup>

A484/A484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings

<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 A01.17 on Flat-Rolled and Wrought Stainless Steel.

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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-638 in Section II of that Code.

<sup>3</sup> 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.

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

A788/A788M Specification for Steel Forgings, General Requirements

E30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron (Withdrawn 1995)<sup>4</sup>

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

## 3. Ordering Information

3.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Such requirements may include, but are not limited to, the following:

3.1.1 Quantity (weight or number of pieces),

3.1.2 Name of material (precipitation hardening iron base superalloy),

3.1.3 Form (bars, forgings, and forging stock),

3.1.4 Dimensions (in the case of rough or finished forgings the order shall be accompanied by a print or drawing or otherwise adequately described as to the shape and dimension),

3.1.5 Grade designation (Table 1),

3.1.6 Condition (Section 5),

3.1.7 Finish (Section 3),

3.1.8 Mechanical requirements (Section 8),

3.1.9 ASTM designation, and

3.1.10 Special requirements.

## 4. General Requirements

4.1 In addition to the requirements of this specification, all requirements of the current edition of Specification A484/A484M shall apply. Forgings shall comply with the Terminology and Forging sections of Specification A788/A788M, which further clarify the forging definitions in the Terminology section of Specification A484/A484M. Failure to comply with the general requirements of Specification A484/A484M constitutes nonconformance with this specification.

<sup>4</sup> The last approved version of this historical standard is referenced on www.astm.org.

\*A Summary of Changes section appears at the end of this standard

**TABLE 1 Mechanical Property Requirements**

	Grade 660	Grade 662 (bars)	Grade 662 (forgings) <sup>A</sup>
Heat treatment <sup>B</sup>	solution + precipitation harden	solution + precipitation harden	solution + precipitation harden
Tensile strength, min:			
psi	130 000	130 000	125 000
[MPa]	[895]	[895]	[860]
Yield strength (0.2 % offset), min:			
psi	85 000	85 000	80 000
[MPa]	[585]	[585]	[550]
Elongation in 4D min, %	15	15	15
Reduction of area min, %	18	18	18
Brinell hardness	248 min	248 min	248 min

<sup>A</sup> The elongation of tensile specimens machined tangentially from near the center of large disk forgings over 50 in.<sup>2</sup> [320 cm<sup>2</sup>] in cross section may be as low as 10 %. The reduction of area may be as low as 12 %.

<sup>B</sup> Refer to [Table 3](#) of heat treatment.

**TABLE 2 Stress-Rupture Requirements**

Grade	Heat Treatment <sup>A</sup>	Test Temperature		Applied Stress During Stress-Rupture Testing		Minimum Hours <sup>B</sup>	Minimum Elongation, %
		°F	[°C]	psi	[MPa]		
660	solution + precipitation harden	1200	[650]	65 000	[450]	23	3
662	solution + precipitation harden	1200	[650]	60 000	[415]	15	3

<sup>A</sup> Refer to [Table 3](#) for details of heat treatment.

<sup>B</sup> Test specimens meeting minimum requirements may be overloaded to produce rupture in a reasonable and practical time period.

**TABLE 3 Heat Treatment**

Grade	Solution Treatment	Precipitation Hardening Treatment <sup>A</sup>
660	Type 1	
	1650 ± 25 °F [900 ± 15 °C], hold 2 h, oil or water quench	1300 to 1400 °F [705 to 760 °C], hold 16 h, air cool or furnace cool
660	Type 2	
	1800 ± 25 °F [980 ± 15 °C], hold 1 h, oil or water quench	1300 to 1400 °F [705 to 760 °C], hold 16 h, air cool or furnace cool
662	1750 to 1900 °F [955 to 1040 °C], hold 1 h, min, oil or water quench	1250 to 1400 °F [675 to 760 °C], hold 5 h, min, slow cooling in 5 h, min, to 1200 ± 15 °F [650 ± 10 °C], hold 20 h, min, air cool or furnace cool

<sup>A</sup> Times refer to the minimum time material is required to be at temperature.

## 5. Condition

5.1 The product forms covered in this specification may be furnished in one of the following conditions:

5.1.1 Hot-finished,

5.1.2 Solution treated (Grade 660 only—Type 1 or Type 2 solution treatment as specified),

5.1.3 Solution and precipitation treated (Grade 660 only—Type 1 or Type 2 solution treatment as specified), or

5.1.4 Other as specified.

## 6. Heat Treatment

6.1 Samples cut from bars, forgings, or a sample forged from the forging stock shall conform to the mechanical properties of [Table 1](#) and [Table 2](#) when heat treated as prescribed in [Table 3](#).

6.2 When a sample cut from the forging stock and heat treated as prescribed in [Table 2](#) conforms to the properties in [Tables 3 and 4](#), it shall be accepted as equivalent to a forged coupon.

## 7. Chemical Composition

7.1 The steel shall conform to the requirements for chemical composition specified in [Table 4](#).

7.2 Methods and practices relating to chemical analysis required by this specification shall be in accordance with Test Methods, Practices, and Terminology [A751](#), except that for remelt material, product analysis tolerances may be used to determine conformance to this specification.

7.3 For referee purposes, Test Methods [E30](#) shall be used.