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Standard Specification for Precipitation Hardening Iron Base Superalloy Forgings for Turbine Rotor Disks and Wheels¹

This standard is issued under the fixed designation A 891/A 891M; 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.

1. Scope*

1.1 This specification covers precipitation hardening iron base superalloy forgings which are primarily intended for use as turbine rotor disks and wheels.

1.2 Two heat treatments are covered. Selection will depend upon design, service conditions, mechanical properties, and elevated temperature characteristics.

1.3 All of the provisions of Specification A 788/A 788M, apply, except as amended herein.

~~1.4 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 The values stated in either SI units or inch-pound units are to be regarded separately as standard. 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 non-conformance with the standard.

2. Referenced Documents

2.1 *ASTM Standards:*²

A 788/A 788M Specification for Steel Forgings, General Requirements

E 112 Test Methods for Determining the Average Grain Size

E 139 Test Methods for Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials

E 165 Test Methods/Method for Liquid Penetrant Examination

E 292 Test Methods for Conducting Time-for-Rupture Notch Tension Tests of Materials

3. Ordering Information

~~3.1 Orders for material under this specification shall include the information specified in Specification A 788 and the following:~~
Ordering Information

3.1 Orders for material under this specification shall include the following:

3.1.1 *Condition*—See Section 4.

3.1.2 *Stress Rupture Test*—Parameters for material furnished in condition 2 of 8.3.37.3.3.

3.1.3 *Forging Drawing*—Each forging shall be manufactured in accordance with a drawing furnished by the purchaser showing the dimensions of the forging and the location of mechanical test specimens.

3.1.4 Include the information specified in Specification A 788/A 788M.

4. ~~Condition~~ Condition and Heat Treatment

4.1 The forgings covered in this specification may be ordered in two different solution treated and aged conditions:

4.1.1 *Type 1:*

4.1.1.1 Solution anneal at $1650 \pm 25^\circ\text{F}$ (~~900~~[900 $\pm 14^\circ\text{C}$]) for 2 to 5 h at temperature liquid quench.

4.1.1.2 Precipitation harden at $1420 \pm 15^\circ\text{F}$ (~~770~~[770 $\pm 8^\circ\text{C}$]) for 16 h at temperature air cool; $1200 \pm 15^\circ\text{F}$ (~~650~~[650 $\pm 8^\circ\text{C}$]) for 16 h at temperature air cool.

4.1.2 *Type 2:*

4.1.2.1 Solution anneal at $1800 \pm 25^\circ\text{F}$ (~~980~~[980 $\pm 14^\circ\text{C}$]) for 2 to 5 h at temperature liquid quench.

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

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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*, Vol 01.05, volume information, refer to the standard's Document Summary page on the ASTM website.

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

4.1.2.2 Precipitation harden at 1420 ± 15°F (770[770 ± 8°C]8°C) for 16 h at temperature air cool; 1200 ± 15°F (650[650 ± 8°C]8°C) for 16 h at temperature air cool.

5. Manufacture

5.1 The material shall be made by vacuum melting followed by consumable electrode vacuum arc or electroslog remelting as agreed upon between producer and user.

5.2 The forgings shall be upset forged so that the axis of the disk corresponds with that of the ingot.

~~6. Chemical Requirements~~ **Chemical Requirements**

6. Chemical Requirements

6.1 *Heat Analysis*—Each heat shall be analyzed by the manufacturer in accordance with Specification A 788/A 788M. The chemical composition shall conform to the requirements specified in Table 1.

7. Heat Treatment

~~7.1 The forgings shall be heat treated in accordance with 4.1~~

6.2 *Product Analysis*—The purchaser may obtain a product analysis, representing each heat or multiple heat, in accordance with the provisions of Specification A 788/A 788M.

8.7. Mechanical Properties

~~8.1 The 7.1~~ The forgings shall conform to the mechanical property requirements specified in Table 2 after heat treatment as prescribed in 4.1.

8.2

7.2 *Tension and Hardness*—Tension and hardness testing shall be conducted in accordance with Specification A 788/A 788/A 788M.

8.3

7.3 *Stress Rupture:*

87.3.1 Combination smooth and notched bar specimens using 0.252 in. (6.4 mm)[6.4 mm] diameter bars shall be tested to rupture in accordance with ~~Practice Test Methods E 292~~. Rupture must occur in the smooth section of each specimen. After 100 h, samples may be uploaded in 5-ksi (35-MPa)[35-MPa] increments in 8 to 16 h intervals.

87.3.2 Material supplied as Type 1 shall meet the stress rupture requirements specified in Table 3.

8.3.3

TABLE 1 Chemical Composition

| Element | Heat and Product Analysis Range, Percentage | Product Analysis Tolerance—Over or Under |
|------------|---|--|
| Carbon | 0.05 max | 0.01 |
| Carbon | 0.05 max | |
| Manganese | 0.50 max | 0.03 |
| Manganese | 0.50 max | |
| Silicon | 0.50 max | 0.05 |
| Silicon | 0.50 max | |
| Phosphorus | 0.025 max | 0.005 |
| Phosphorus | 0.025 max | |
| Sulfur | 0.015 max | 0.005 |
| Sulfur | 0.015 max | |
| Chromium | 13.50–16.00 | 0.20 |
| Chromium | 13.50–16.00 | |
| Nickel | 24.00–27.00 | 0.20 |
| Nickel | 24.00–27.00 | |
| Molybdenum | 1.00–1.50 | 0.05 |
| Molybdenum | 1.00–1.50 | |
| Titanium | 1.90–2.35 | 0.07 |
| Titanium | 1.90–2.35 | |
| Boron | 0.003–0.010 | 0.001 |
| Boron | 0.003–0.010 | over |
| Boron | 0.003–0.010 | |
| Vanadium | 0.10–0.50 | 0.03 |
| Vanadium | 0.10–0.50 | |
| Aluminum | 0.35 max | 0.05 |
| Aluminum | 0.35 max | |
| Iron | remainder | |

0.0004 under