Designation: A 288 – 91 (Reapproved 2008)

Standard Specification for Carbon and Alloy Steel Forgings for Magnetic Retaining Rings for Turbine Generators[1]

This standard is issued under the fixed designation A 288; 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 quenched and tempered carbon and alloy steel forgings for magnetic retaining rings for turbine generators.

1.2 Supplementary requirements of an optional nature are provided. These shall apply only when specified by the purchaser.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 275/A 275M Practice for Magnetic Particle Examination of Steel Forgings

A 531/A 531M Practice for Ultrasonic Examination of Turbine-Generator Steel Retaining Rings

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

3. Ordering Information

3.1 In addition to the ordering information required by Specification A 788/A 788M, the purchaser shall include with the inquiry and order a detailed drawing, sketch, or written description of the forging, including the number and location of mechanical test specimens.

4. Manufacture

4.1 The melting processes of Specification A 788/A 788M shall be applicable except that the basic electric furnace process shall be used if separate refining or remelting is not employed.

4.2 *Vacuum Degassing*—For Class 3 machined forgings over 2½ in. (63.5 mm) wall thickness, and Classes 4 to 8, the molten steel shall be vacuum treated immediately prior to or during the operation of pouring the ingot in order to remove objectionable gases, especially hydrogen.

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

4.4 *Heat Treatment*:

4.4.1 *Heat Treatment for Mechanical Properties*—Heat treatment for properties shall be by quenching and tempering.

4.4.2 *Tempering Temperature*—The final tempering temperature shall be not less than 1100°F (595°C).

4.5 *Machining*:

4.5.1 *Preliminary Machining*—Forgings shall be machined all over prior to quenching and tempering for mechanical properties.

4.5.2 *Machine to Purchaser's Requirements for Shipment*—If required, forgings shall be machined to the dimensions shown on the purchaser's drawing prior to shipment.

5. Chemical Composition

5.1 The steel shall conform to the chemical composition prescribed in Table 1.

5.2 *Heat Analysis*—The heat analysis obtained from sampling in accordance with Specification A 788/A 788M shall comply with Table 1.

5.3 *Product Analysis*—The purchaser may use the product analysis provision of Table 1 of Specification A 788/A 788M to obtain a product analysis from a forging representing each heat or multiple heat.

[1] 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.

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

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TABLE 1 Chemical Requirements

	Class 1, %	Classes 2 and 3, %	Classes 4, 5, 6, 7, and 8, %
Carbon, max	0.50 max	0.45 max	0.45
Manganese	0.60–1.00	0.60–1.00	1.00 max
Phosphorus, max	0.025	0.025	0.025
Sulfur, max	0.025	0.020	0.020
Silicon	0.15–0.30	0.15–0.35	0.15–0.35
Nickel	. . .	[A]	1.65–3.50
Chromium	. . .	0.70–1.25	0.70–1.25
Molybdenum	. . .	0.15 min	0.20 min
Vanadium	. . .	optional	0.07–0.12

[A] For Class 3 rings with wall thickness over 2½ in. (63.5 mm) drawing size, the nickel content shall be 0.85–2.0 %.

6. Mechanical Properties

6.1 *Tensile Requirements*—The material shall conform to the requirements for tensile properties prescribed in Table 2.

6.2 *Notch Toughness Requirements*—The material shall conform to the requirements for notch toughness as prescribed in Table 2.

7. General Requirements

7.1 Material supplied to this specification shall conform to the requirements of Specification A 788/A 788M which outlines additional ordering information, manufacturing, requirements, testing and retesting methods, and procedures, marking, certification, product analysis variations, and additional supplementary requirements.

TABLE 2 Tensile and Notch Toughness Requirements

Class	Tensile Strength min, psi (MPa)	Yield Strength (0.02 %, offset), min, psi (MPa)	Elongation in 2 in. or 50 mm, min, %	Reduction of Area, min, %	Charpy V-notch Impact Strength, Room Temperature min, ft-lbf (J)
1	70 000 (485)	45 000 (310)	18	40	15 (20)
2	90 000 (620)	65 000 (450)	20	50	25 (34)
3	110 000 (760)	80 000 (550)	18	50	20 (27)
4	120 000 (825)	95 000 (655)	18	45	35 (47)
5	130 000 (895)	110 000 (760)	16	40	30 (41)
6	140 000 (965)	125 000 (860)	14	40	30 (41)
7	150 000 (1035)	135 000 (930)	13	35	25 (34)
8	165 000 (1140)	150 000 (1035)	12	35	25 (34)

7.2 If the requirements of this specification are in conflict with the requirements of Specification A 788/A 788M, the requirements of this specification shall prevail.

8. Sampling

8.1 *Test Location*—Tension and notch toughness test specimens shall be taken tangentially from prolongations on one or both ends of the forging. The direction of the notch of the Charpy bars shall be radial. All test specimens shall be located at midwall and at a distance at least equal to one-half the wall thickness from the end face of the prolongation.

8.2 *Removal*—All tension and notch toughness test specimens shall be removed after final heat treatment.

9. Number of Tests and Retests

9.1 *Number of Tests*—The number of tension and notch toughness test specimens shall be as prescribed by the purchaser, but in no case shall there be less than one tension and one notch toughness test specimen for each ring.

9.2 If any test specimen fails to meet the requirements specified, two adjacent test specimens may be selected for retest without reheat-treatment if the failure was not caused by ruptures, cracks, or flakes in the steel. Both of these must meet the requirements of this specification.

9.3 If the results of the mechanical tests of any forging do not conform to the requirements specified, the manufacturer may reaustenitize the forging, but not more than once without approval of the purchaser. Forgings may be retempered without obtaining approval of the purchaser.

10. Test Methods

10.1 *Nondestructive Tests*:

10.1.1 *General Requirements*—The ring shall be free from cracks, seams, laps, shrinkage, and other injurious imperfections.

10.1.2 *Magnetic Particle Test*—Magnetic particle tests of all surfaces shall be made at the manufacturer's plant. The procedure for tests shall be in accordance with Practice A 275/A 275M. The standards of acceptance shall be by agreement between purchasers and manufacturers.

10.1.3 *Ultrasonic Inspection*—An ultrasonic inspection shall be made at the manufacturer's plant on the machined ring in accordance with Practice A 531/A 531M. The standards of acceptance shall be by agreement between purchaser and manufacturer.

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