



Designation: A 469 – 94a (Reapproved 1999)

Standard Specification for Vacuum-Treated Steel Forgings for Generator Rotors¹

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1. Scope

1.1 This specification covers vacuum-treated basic electric steel forgings for generator rotors.

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

2. Referenced Documents

2.1 ASTM Standards:

A 275/A 275M Test Method for Magnetic Particle Examination of Steel Forgings²

A 341 Test Method for Direct-Current Magnetic Properties of Materials Using D-C Permeameters and the Ballistic Test Methods³

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products⁴

A 418 Test Method for Ultrasonic Examination of Turbine and Generator Steel Rotor Forgings²

A 773 Test Method for D-C Magnetic Properties of Materials Using Ring and Permeameter Procedures with D-C Electronic Hysteresigraphs³

A 788 Specification for Steel Forgings, General Requirements²

3. Ordering Information and General Requirements

3.1 In addition to the ordering information required by Specification A 788, the purchaser shall include with the inquiry and order, a dimensioned drawing showing the mechanical test specimen locations, and details of magnetic permeability tests, if required.

3.2 Material supplied to this specification shall conform to the requirements of Specification A 788, which outlines additional ordering information, manufacturing requirements, testing and retesting methods and procedures, marking, certifica-

tion, production analysis variations, and additional supplementary requirements.

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

4. Materials and Manufacture

4.1 The vacuum degassing requirements of Specification A 788 are mandatory. In addition to these requirements, hydrogen testing per Supplementary Requirement S4 is mandatory.

4.1.1 When the ladle degassing process is used, the evacuation system shall be capable of reducing the system vacuum pressure to a low level (usually less than 1000 μ m). The molten metal shall be adequately stirred for a sufficient length of time to maximize exposure to the evacuated atmosphere. When this process is used, hydrogen testing per Supplementary Requirement S4 is mandatory.

4.1.2 Other methods of degassing may be used if the supplier can demonstrate their adequacy to the satisfaction of the purchaser. When other processes are used, hydrogen testing per Supplementary Requirement S4 is mandatory.

4.2 Heat Treatment:

4.2.1 If possible, forgings should be heat treated in the vertical position. Supplementary Requirement S3 makes this mandatory, if activated in the ordering information.

4.2.2 The heat treatment for mechanical properties shall consist of quenching and tempering, but normalizing and tempering is permissible with prior purchaser approval. Also, with prior purchaser approval, the post rough machining stress relief in 4.2.3 may be omitted when double tempering is used, instead of a single temper, to complete this heat treatment cycle.

4.2.3 After heat treatment and the subsequent rough machining, the forging shall be stress relieved at a minimum temperature of 1050°F (566°C), unless otherwise specified by the purchaser.

4.3 Machining:

4.3.1 *Boring*—The manufacturer may bore the forging at any time prior to stress-relief anneal. (See Supplementary Requirement S1).

¹ This specification is under the jurisdiction of ASTM Committee A-1 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 *Annual Book of ASTM Standards*, Vol 01.05.

³ *Annual Book of ASTM Standards*, Vol 03.04.

⁴ *Annual Book of ASTM Standards*, Vol 01.03.

5. Chemical Composition

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

5.2 *Product Analysis*—The manufacturer shall use the product analysis provision of Specification A 788 to obtain a product analysis from a forging representing each heat or multiple heat.

6. Magnetic Properties

6.1 When specified in the ordering information, a permeability test shall be performed in accordance with the latest issue of Test Method A 341 or Test Method A 773.

7. Mechanical Properties

7.1 *Tension Test:*

7.1.1 The steel shall conform to the requirements of Table 2.

7.1.2 The number of locations of tension test specimens shall be as specified on the forging drawings furnished by the purchaser.

7.1.3 Tests for acceptance shall be made after heat treatment of the forging for mechanical properties. The purchaser may require check tests after completion of all heating cycles including stress relieving in accordance with 4.2.3.

7.1.4 Testing shall be performed in accordance with the latest issue of Test Methods and Definitions A 370. Tension specimens shall be the standard 0.5 in. (13.7 mm) round by 2-in. (50.8-mm) gage length, as shown in Test Methods and Definitions A 370.

7.1.5 The yield strength prescribed in Table 2 shall be determined by the offset method in Test Methods and Definitions A 370.

7.2 *Impact Test:*

7.2.1 The material shall conform to the requirements for notch toughness (both transition temperature and room temperature impact value) prescribed in Table 2.

7.2.2 Charpy V-notch specimens from surface radial test locations shall be oriented with the root of the notch perpendicular to a radial line of the forging and parallel to the axis of the forging. The notch shall be located as far below the heat treated surface of the forging as possible without exceeding the dimensions specified for the test material. The notch-toughness

specimens shall conform to the Charpy V-notch specimen configuration, as shown in the latest issue of Test Methods and Definitions A 370.

8. Nondestructive Test Requirements

8.1 *General Requirements:*

8.1.1 The forgings shall be free of cracks, seams, laps, shrinkage, and other injurious imperfections.

8.1.2 The purchaser may request such tests and inspection methods including ultrasonic, magnetic particle, or etch tests, as are necessary to ensure compliance with this requirement.

8.2 *Ultrasonic Inspection:*

8.2.1 An ultrasonic inspection shall be made at the forging manufacturer’s plant on the machined forgings. In making the ultrasonic inspection, reference shall be made to the latest issue of Test Method A 418.

8.2.2 Forgings having recordable ultrasonic indications shall be referred to the purchaser and evaluated on the basis of nature, frequency, and locations of indications both traveling and stationary. If the ultrasonic indications are considered objectionable, it shall be determined by conventional or mutually acceptable inspection procedures whether the forging will be rejected.

8.2.3 Forgings shall be ultrasonically tested prior to removal of the mid-body radial tension coupons.

8.3 *Internal Inspection*—Boring, when specified for periscopic inspection, shall be as shown on the drawings furnished by the purchaser. The drawings shall specify the nominal dimensions of the hole. Magnetic particle examination of the bore surface shall be performed in accordance with the latest issue of Test Method A 275/A 275M. In cases where objectionable conditions are revealed, the manufacturer shall advise the purchaser and any further action shall be taken only after mutual agreement.

9. Retreatment

9.1 If the results of the mechanical tests of any forging do not conform to the requirements specified, the manufacturer may retreat the forging one or more times, but not more than three additional times without approval of the purchaser, and retests shall be made in accordance with 7.1.2.

TABLE 1 Chemical Requirements

Element	Composition, %					
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6, 7, 8
Carbon, max	0.45	0.25	0.27	0.27	0.31	0.28
Manganese, max	0.90	0.60	0.60	0.70	0.70	0.60
Phosphorus, max	0.015	0.015	0.015	0.015	0.015	0.015
Sulfur, max	0.015	0.015	0.015	0.015	0.015	0.015
Silicon ^A	0.15 to 0.35	0.15 to 0.30	0.15 to 0.30	0.15 to 0.30	0.15 to 0.30	0.15 to 0.30
Nickel	...	2.50 min	2.50 min	3.00 min	3.00 min	3.25 to 4.00
Chromium	...	0.50 max	0.50 max	0.50 max	0.50 max	1.25 to 2.00
Molybdenum	...	0.20 to 0.50	0.20 to 0.50	0.20 to 0.60	0.20 to 0.70	0.30 to 0.60
Vanadium	0.03 to 0.12 ^B	0.03 min	0.03 min	0.03 min	0.05 to 0.15	0.05 to 0.15
Antimony ^C

^A Optional: Classes 2 to 8 steel may be vacuum deoxidized, silicon 0.10 max.

^B Vanadium addition optional for Class 1.

^C Information on Classes 6, 7, and 8.