



Designation: A 469/A 469M – 04

Standard Specification for Vacuum-Treated Steel Forgings for Generator Rotors¹

This standard is issued under the fixed designation A 469/A 469M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

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

1.2 Supplementary requirements are provided, both in this standard and in Specification A 788, for use when additional testing, inspection or processing is required by the purchaser.

1.3 The values stated in either inch-pound or SI (metric) units are to be regarded separately as standards. Within the text and tables, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independent of the other. Combining values from the two systems may result in nonconformance with the specification.

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

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

2. Referenced Documents

2.1 ASTM Standards:²

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

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

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

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

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

A 788 Specification for Steel Forgings, General Requirements

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, together with:

3.1.1 Details of any required magnetic permeability tests (6.1).

3.1.2 If the yield strength is to be determined at an offset of 0.2 % (Table 1), and number of tests (7.1.2 and 7.1.3).

3.1.3 If vertical heat treatment is required (S3).

3.1.4 If heat treatment by normalizing and tempering is required (4.2.2 and 4.2.3).

3.1.5 If post rough machining stress relief may be omitted for forgings that have been double tempered (4.2.2).

3.1.6 Details for boring including dimensions, finish, timing and additional testing if required (8.3 and S1).

3.1.7 Any applicable instructions regarding the required nondestructive examinations (8).

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, certification, production analysis variations, and additional supplementary requirements.

3.3 Failure to comply with the applicable general requirements of Specification A 788 constitutes nonconformance with this specification.

3.4 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.

4.1.1 Other vacuum methods of degassing may be used if the supplier can demonstrate their adequacy to the satisfaction of the purchaser, but in this case, hydrogen testing per Supplementary Requirement S4 is mandatory.

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.



TABLE 1 Tensile and Notch Toughness Requirements

	Grade						
	2	3	4	5	6	7	8
Tensile strength, min, ksi	80	90	100	110	100	110	120
[MPa]	[550]	[620]	[690]	[760]	[690]	[760]	[825]
Yield strength, ^A min, ksi	55	70	80	90	80	90	100
[MPa]	[380]	[485]	[550]	[620]	[550]	[620]	[690]
Elongation in 2 in. or 50 mm, min, %	20	20	17	15	18	17	16
Reduction of area, min, %	50	50	45	40	55	50	45
FATT ₅₀ , max, F	100	100	120	175	0	20	40
[FATT ₅₀ , max, C]	[38]	[38]	[49]	[80]	[-18]	[-7]	[4]
Charpy absorbed energy at 70 ± 5 °F [20 ± 3 °C], min, ft-lbf[J]	30	30	25	15	60	50	40
	[40]	[40]	[34]	[20]	[80]	[68]	[55]

^A Yield strength at 0.02 % offset. Yield strength may also be specified at 0.2 % offset in which case 5000 psi (35 MPa) shall be added to these values.

4.2 Heat Treatment:

4.2.1 Vertical heat treatment of the rotor forging is preferred, and supplementary requirement S3 should be specified by the purchase order if this is required.

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 [565°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).

5. Chemical Composition

5.1 Heat Analysis—The heat analysis obtained from sampling in accordance with Specification A 788 shall comply with Table 2.

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 1.

7.1.2 The number and 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; however, the ultrasonic examination requirements of 8.2.3 must be considered. 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.

7.1.5 The yield strength prescribed in Table 1 shall be determined by the offset method at 0.02 % as described 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 fracture appearance transition temperature (FATT) and room temperature absorbed energy value) prescribed in Table 1.

TABLE 2 Chemical Requirements

Element	Composition, %				
	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6, 7, 8
Carbon, max	0.25	0.27	0.27	0.31	0.28
Manganese, max	0.60	0.60	0.70	0.70	0.60
Phosphorus, max	0.015	0.015	0.015	0.015	0.015
Sulfur, max	0.015	0.015	0.015	0.015	0.015
Silicon ^A	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 min	0.03 min	0.03 min	0.05 to 0.15	0.05 to 0.15
Antimony ^B

^A Optional: For steel that is to be vacuum arc remelted a minimum silicon of 0.15 % may be specified.

^B Report for information on Grades 6, 7, and 8.