



Designation: A 579 – 01

## Standard Specification for Superstrength Alloy Steel Forgings<sup>1</sup>

This standard is issued under the fixed designation A 579; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 1. Scope

1.1 This specification covers requirements for forged steel shapes for highly stressed structural members requiring yield strengths in excess of 140 ksi (965 MPa) (0.2 % offset).

1.2 This specification is not intended for applications limited by creep deformation.

1.3 Twenty-seven grades are covered by this specification. Selection will depend upon design, service conditions, and mechanical properties required.

1.4 Supplementary requirements are provided for use when additional testing or inspection is desired. These shall apply only when specified individually by the purchaser in the order.

1.5 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

### 2. Referenced Documents

#### 2.1 *ASTM Standards:*

A 255 Test Methods for Hardenability of Steel<sup>2</sup>

A 275/A 275M Test Method for Magnetic Particle Examination of Steel Forgings<sup>2</sup>

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products<sup>3</sup>

A 388/A 388M Practice for Ultrasonic Examination of Heavy Steel Forgings<sup>2</sup>

A 788 Specification for Steel Forgings, General Requirements<sup>2</sup>

E 3 Methods of Preparation of Metallographic Specimens<sup>4</sup>

E 21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials<sup>4</sup>

E 45 Test Methods for Determining the Inclusion Content of Steel<sup>4</sup>

E 112 Test Methods for Determining Average Grain Size<sup>4</sup>

E 165 Test Method for Liquid Penetrant Examination<sup>5</sup>

<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 A01.06 on Steel Forgings and Billets.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 01.05.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 01.03.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 03.01.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 03.03.

### 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 detailed drawing, sketch, or written description of the forging.

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, product 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 steel shall be made in accordance with the Melting Process Section of Specification A 788. A sufficient discard shall be made to secure freedom from injurious pipe and undue segregation.

4.2 The material shall be forged as close as practical to the specified shape and size.

4.3 The finished product shall be a hot-worked forging as defined by Specification A 788.

4.4 *Heat Treatment Performed by Forging Supplier*—Forgings may be furnished in one of the following conditions as specified in the inquiry and purchase order (some conditions are not applicable to all grades):

4.4.1 Stress relieved,

4.4.2 Annealed,

4.4.3 Solution treated,

4.4.4 Solution treated and aged,

4.4.5 Normalized,

4.4.6 Normalized and tempered, or

4.4.7 Quenched and tempered.

4.5 *Heat Treatment Performed by Purchaser*—When final heat treatment is to be performed by the purchaser after machining or fabrication, or both, a capability heat treatment duplicating the purchaser's final heat treatment must be performed by the supplier on representative samples (see 6.3) to

qualify the forgings. The results of these capability tests shall conform to the requirements of Table 1 and Table 2. See also Table 3.

### 5. Chemical Requirements

5.1 *Heat Analysis*—The heat analysis obtained from sampling in accordance with Specification A 788 shall comply with Table 4.

5.2 *Product Analysis*—The purchaser may use the product analysis provision of Specification A 788 to obtain a product analysis from a forging representing each heat or multiple heat (see Table 5).

### 6. Mechanical Properties

6.1 The material shall conform to the mechanical properties specified in Table 1, when ordered to 4.4.4 or 4.4.7. For the other heat treatments specified in 4.4, the provisions of 4.5 apply.

6.2 Tension tests are required for all material ordered to this specification. However, room-temperature Charpy V-notch impact tests are required only for those grades which have minimum impact strength requirements listed in Table 2.

6.3 Tests shall be conducted in accordance with the latest issue of Test Methods and Definitions A 370. The largest obtainable tension test specimen as specified in Test Methods

**TABLE 1 Minimum Tension Test Requirements**

Grade	Yield Strength (0.2 % offset), ksi (MPa)	Tensile Strength, ksi (MPa)	Elongation, <sup>A</sup> %	Reduction of Area, <sup>A</sup> %
Quench and Tempered				
13, 21, 22, 23, 12, 12a	140 (965)	150 (1035)	13	40
13, 21, 22, 23, 11	160 (1100)	175 (1210)	12	36
13, 21, 22, 23, 31	180 (1240) <sup>B</sup>	190 (1310)	10	32
13, 21, 22, 23	200 (1380) <sup>B</sup>	210 (1450)	9	28
22 <sup>C</sup> , 23, 32, 33	225 (1550) <sup>B</sup>	250 (1720)	6	25
Air Hardening				
41	200 (1380) <sup>B</sup>	260 (1790)	9	30
41	225 (1550) <sup>B</sup>	280 (1930)	8	25
Martensitic Stainless				
51, 52, 53	140 (965)	175 (1210)	12	45
52	160 (1100)	220 (1520)	10	40
No. 1 Precipitation Hardening Stainless				
61	140 (965)	165 (1140)	12	50
61	160 (1100)	180(1240)	10	45
61	180 (1240) <sup>B</sup>	200(1380)	8	40
No. 2 Precipitation Hardening Stainless				
64	140 (965)	165 (1140)	12	25
64	160 (1100)	185 (1280)	10	25
64	180 (1240) <sup>B</sup>	210 (1450)	10	25
No. 3 Precipitation Hardening Stainless				
62	140 (965)	165 (1140)	6	25
62, 63	160 (1100)	180 (1240)	6	25
63	180 (1240) <sup>B</sup>	200 (1380)	6	25
63	200 (1380) <sup>B</sup>	225 (1550)	5	25
Maraging Steels				
74	160 (1100)	170 (1170)	15	65
75	180 (1240) <sup>B</sup>	190 (1310)	14	60
71	200 (1380) <sup>B</sup>	210 (1450)	12	55
72	250 (1720) <sup>B</sup>	255 (1760)	10	45
73	275 (1900) <sup>B</sup>	280 (1930)	9	40
Miscellaneous				
81	180 (1240) <sup>D</sup>	190 (1310)	13	45
82	200 (1380) <sup>D</sup>	210 (1450)	10	30
83 <sup>D</sup>	225 (1550) <sup>D</sup>	260 (1790)	7	20
83 <sup>E</sup>	250 (1720) <sup>D</sup>	280 (1930)	4	15
84	180 (1240) <sup>D</sup>	185	14	45

<sup>A</sup> See Note in Table 3.

<sup>B</sup> Vacuum melting normally required to achieve list properties.

<sup>C</sup> By agreement.

<sup>D</sup> Bainitic.

<sup>E</sup> Martensitic.

**TABLE 2 Minimum Room-Temperature Charpy V-Notch Energy Absorption<sup>A</sup> for Respective Yield Strength Classes, ft-lbf(J)**

Grade	Yield Strength Class, ksi (MPa)						
	140 (965)	160 (1100)	180 <sup>B</sup> (1240)	200 <sup>B</sup> (1380)	225 <sup>B</sup> (1550)	250 <sup>B</sup> (1720)	275 <sup>B</sup> (1900)
11	...	45 (61)	...	...	...	...	...
12, 12a	50 (68)	...	...	...	...	...	...
13	20 (27)	10 (14)	c	...	...	...	...
21	35 (47)	30 (41)	20 (27)	15 (20)	...	...	...
22	30 (41)	25 (34)	20 (27)	15 (20)	...	...	...
23	35 (47)	25 (34)	20 (27)	15 (20)	10 (14)	...	...
31	...	...	25 (34)	...	...	...	...
32	...	...	...	...	12 (16)	...	...
33	...	...	...	...	15 (20)	...	...
41	...	...	...	15 (20)	c	...	...
51	15 (20)	...	...	...	...	...	...
52	c	c	...	...	...	...	...
53	c	...	...	...	...	...	...
61	25 (34)	...	c	...	...	...	...
62	c	c	...	...	...	...	...
63	c	c	c	...	...	...	...
64	25 (34)	15 (20)	15 (20)	...	...	...	...
71	...	...	...	35 (47)	...	...	...
72	...	...	...	...	...	20 (27)	...
73	...	...	...	...	...	...	15 (20)
74	...	60 (81)	50 (68)	...	...	...	...
81	...	...	25 (34)	...	...	...	...
82	...	...	...	20 (27)	...	...	...
83	...	...	...	...	15 (20)	10 (14)	...
84	...	...	25 (34)	...	...	...	...

<sup>A</sup> See Note in Table 3.

<sup>B</sup> Vacuum melting may be required to achieve listed properties.

<sup>C</sup> By agreement.

and Definitions A 370 shall be used. Impact specimens shall be the standard size, Charpy V-notch, as shown in the figure for the Charpy (Simple-Beam) Impact Test of Test Methods and Definitions A 370. The use of subsize impact specimens requires prior purchaser approval.

6.4 The longitudinal axis of the specimens shall be parallel to the direction of major working of the forging. For upset-disc forgings, the longitudinal axis of the test specimen shall be in the tangential direction.

6.4.1 The longitudinal axis of the specimen shall be located midway between the parallel surfaces of the test extension if added to the periphery of disks or midway between the center and surface of solid forgings. For hollow forgings, the longitudinal axis of the specimens shall be located midway between the center and outer surfaces of the wall. When separately forged test blocks are employed as defined in 6.4.3, the tension test specimens shall be taken from a location which represents the midwall of the heaviest section of the production forgings. When specimens are required from opposite ends, they shall be taken from the diagonal corners of an axial plane.

6.4.2 Except as specified herein, tests for acceptance shall be made after heat treatment has been completed.

6.4.3 When mutually agreed upon between manufacturer and purchaser, test specimens may be machined from a specially forged block suitably worked and heat treated with the production forgings. Such a special block shall be obtained from an ingot, slab, or billet from the same heat used to make the forgings it represents. This block shall receive essentially the same type of hot working and forging reduction as the production forgings; however, a longitudinally forged bar with dimensions not less than  $T$  by  $T$  by  $3T$  may be used to represent

a ring forging. The dimension  $T$  shall be representative of the heaviest effective cross section of the forging. For quenched and tempered forgings for which tests are required at both ends by 6.5.2.3 and 6.5.2.4, separately forged test blocks are not allowed.

NOTE 1—In using separately forged test blocks, attention is drawn to the effect of mass differences between the production forgings and the test blocks.

6.5 *Specific Requirements*—The number and location of tests are based on forging length, weight, and heat treatment and shall be as prescribed below. The length and weight to be used for this purpose shall be the shipped length and weight of forgings produced individually or the aggregate shipped length and weight of all pieces cut from a multiple forging.

6.5.1 *Stress Relieved, Annealed Solution, Treated, Solution Treated and Aged, Normal or Normalized and Tempered Forgings:*

6.5.1.1 For forgings weighing 5000 lb (2250 kg) or less at the time of heat treatment, one tension test shall be taken from one forging per heat in each heat-treatment charge. When heat treatment is performed in continuous-type furnaces with suitable temperature controls and equipped with recording pyrometers so that complete heat-treatment records are available, a tempering charge may be considered as any continuous run not exceeding an 8-h period.

6.5.1.2 For forgings and forged bars weighing over 5000 lb (2250 kg) at the time of heat treatment, one tension test shall be taken from each forging.

6.5.2 *Quenched and Tempered Forgings:*