Designation: A579/A579M – 17

Standard Specification for Superstrength Alloy Steel Forgings[1]

This standard is issued under the fixed designation A579/A579M; 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 requirements for forged steel shapes for highly stressed structural members requiring yield strengths in excess of 140 ksi [965 MPa].

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

1.3 Twenty-eight 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 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.

1.6 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]

A255 Test Methods for Determining Hardenability of Steel
A275/A275M Practice for Magnetic Particle Examination of Steel Forgings
A370 Test Methods and Definitions for Mechanical Testing of Steel Products
A388/A388M Practice for Ultrasonic Examination of Steel Forgings
A788/A788M Specification for Steel Forgings, General Requirements
E3 Guide for Preparation of Metallographic Specimens
E21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials
E45 Test Methods for Determining the Inclusion Content of Steel
E112 Test Methods for Determining Average Grain Size
E165/E165M Practice for Liquid Penetrant Examination for General Industry

3. Ordering Information and General Requirements

3.1 In addition to the ordering information required by Specification A788/A788M, 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 A788/A788M, 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 A788/A788M, 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 A788/A788M. 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 A788/A788M.

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,

[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.

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

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 A788/A788M shall comply with Table 4.

5.2 *Product Analysis*—The product analysis provisions of Specification A788/A788M may be used by the purchaser.

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 A370. The largest obtainable tension test specimen as specified in Test Methods and Definitions A370 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 A370. The use of subsize impact specimens requires prior purchaser approval.

TABLE 1 Minimum Tension Test Requirements

Grade	Yield Strength (0.2 % offset), ksi [MPa]	Tensile Strength, ksi [MPa]	Elongation,[A] %	Reduction of Area,[A] %
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][B]	190 [1310]	10	32
13, 21, 22, 23	200 [1380][B]	210 [1450]	9	28
22[C] , 23, 32, 33	225 [1550][B]	250 [1720]	6	25
Air Hardening				
41	200 [1380][B]	260 [1790]	9	30
41	225 [1550][B]	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][B]	200 [1380]	8	40
No. 2 Precipitation Hardening Stainless				
64	140 [965]	165[(1140]	12	25
64	160 [1100]	185 [1275]	10	25
64	180 [1240][B]	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][B]	200 [1380]	6	25
63	200 [1380][B]	225 [1550]	5	25
Maraging Steels				
74	160 [1100]	170 [1170]	15	65
75	180 [1240][B]	190 [1310]	14	60
71	200 [1380][B]	210 [1450]	12	55
72	250 [1720][B]	255 [1760]	10	45
73	275 [1895][B]	280 [1930]	9	40
Miscellaneous				
81	180 [1240][D]	190 [1310]	13	45
82	200 [1380][D]	210 [1450]	10	30
83[D]	225 [1550][D]	260 [1790]	7	20
83[E]	250 [1720][D]	280 [1930]	4	15
84	180 [1240][D]	185 [1275]	14	45
85	180 [1240]	210 [1450]	10	35

[A] See Note in Table 3.
[B] Vacuum melting normally required to achieve list properties.
[C] By agreement.
[D] Bainitic.
[E] Martensitic.

TABLE 2 Minimum Room-Temperature Charpy V-Notch Energy Absorption[A] for Respective Yield Strength Classes, ft·lbf [J]

Grade	Yield Strength Class, ksi [MPa]						
	140 [965]	160 [1100]	180[B] [1240]	200[B] [1380]	225[B] [1550]	250[B] [1720]	275[B] [1900]
11	. . .	45 [60]	. . .	. . .	. . .	. . .	. . .
12, 12a	50 [70]	. . .	. . .	. . .	. . .	. . .	. . .
13	20 [25]	10 [15]	[C]	. . .	. . .	. . .	. . .
21	35 [45]	30 [40]	20 [25]	15 [20]	. . .	. . .	. . .
22	30 [40]	25 [35]	20 [25]	15 [20]	. . .	. . .	. . .
23	35 [45]	25 [35]	20 [25]	15 [20]	10 [15]	. . .	. . .
31	. . .	. . .	25 [35]	. . .	. . .	. . .	. . .
32	. . .	. . .	. . .	. . .	12 [17]	. . .	. . .
33	. . .	. . .	. . .	. . .	15 [20]	. . .	. . .
41	. . .	. . .	. . .	15 [20]	[C]	. . .	. . .
51	15 [20]	. . .	. . .	. . .	. . .	. . .	. . .
52	[C]	[C]	. . .	. . .	. . .	. . .	. . .
53	[C]	. . .	. . .	. . .	. . .	. . .	. . .
61	25 [35]	. . .	[C]	. . .	. . .	. . .	. . .
62	[C]	[C]	. . .	. . .	. . .	. . .	. . .
63	[C]	[C]	[C]	. . .	. . .	. . .	. . .
64	25 [35]	15 [20]	15 [20]	. . .	. . .	. . .	. . .
71	. . .	. . .	. . .	35 [45]	. . .	. . .	. . .
72	. . .	. . .	. . .	. . .	. . .	20 [25]	. . .
73	. . .	. . .	. . .	. . .	. . .	. . .	15 [20]
74	. . .	60 [80]	50 [70]	. . .	. . .	. . .	. . .
81	. . .	. . .	25 [35]	. . .	. . .	. . .	. . .
82	. . .	. . .	. . .	20 [25]	. . .	. . .	. . .
83	. . .	. . .	. . .	. . .	15 [20]	10 [15]	. . .
84	. . .	. . .	25 [35]	. . .	. . .	. . .	. . .
85	. . .	. . .	40 [55]	. . .	. . .	. . .	. . .

[A] See Note in Table 3.
[B] Vacuum melting may be required to achieve listed properties.
[C] By agreement.

TABLE 3 Material, Maximum Annealed Hardness (HB), and Section Size Capability in Inches [mm] for Respective Yield Strength Classes

NOTE 1—Tables 1-3 show grades and maximum section sizes in which the indicated yield strength levels can usually be achieved at a ¼ thickness depth in the direction of maximum working. Because of variations in forging configuration and processing it does not follow that the ductility and impact strengths listed in Table 1 and Table 2 can always be obtained at these depths. The properties listed are minimums, unless otherwise agreed by purchaser and manufacturer.

Grade	Maximum Annealed Hardness (HB)	Yield Strength Class, ksi [MPa]						
		140 [965]	160 [1100]	180 [1240]	200 [1380]	225 [1550]	250 [1720]	275 [1900]
11	321	. . .	6.5 [165]	. . .	. . .	. . .	. . .	. . .
12, 12a	. . .	4.0 [100]	. . .	. . .	. . .	. . .	. . .	. . .
13	229	1.0 [25]	1.0 [25]	1.0 [25]	. . .	. . .	. . .	. . .
21	285	4.5 [115]	4.5 [115]	4.0 [100]	4.0 [100]	. . .	. . .	. . .
22	302	4.5 [115]	4.5 [115]	4.0 [100]	4.0 [100]	3.5 [90]	. . .	. . .
23	302	8.0 [200]	8.0 [200]	8.0 [200]	8.0 [200]	8.0 [200]	. . .	. . .
31	262	. . .	. . .	3.0 [75]	. . .	. . .	. . .	. . .
32	302	. . .	. . .	. . .	. . .	5.5 [140]	. . .	. . .
33	302	. . .	. . .	. . .	. . .	2.0 [50]	. . .	. . .
41	235	. . .	. . .	. . .	6.0 [150]	6.0 [150]	. . .	. . .
51	197	2.0 [50]	. . .	. . .	. . .	. . .	. . .	. . .
52	255	2.0 [50]	2.0 [50]	. . .	. . .	. . .	. . .	. . .
53	285	4.0 [100]	. . .	. . .	. . .	. . .	. . .	. . .
61	375	8.0 [200]	8.0 [200]	1.0 [25]	. . .	. . .	. . .	. . .
62	207	6.0 [150]	6.0 [150]	. . .	. . .	. . .	. . .	. . .
63	241	. . .	6.0 [150]	6.0 [150]	6.0 [150]	. . .	. . .	. . .
64	321	6.0 [150]	6.0 [150]	6.0 [150]	. . .	. . .	. . .	. . .
71	321	. . .	. . .	. . .	12.0 [300]	. . .	. . .	. . .
72	321	. . .	. . .	. . .	. . .	. . .	12.0 [300]	. . .
73	321	. . .	. . .	. . .	. . .	. . .	. . .	12.0 [300]
74	321	. . .	12.0 [300]	. . .	. . .	. . .	. . .	. . .
75	321	. . .	. . .	12.0 [300]	. . .	. . .	. . .	. . .
81	341	. . .	. . .	6.0 [150]	. . .	. . .	. . .	. . .
82	341	. . .	. . .	. . .	5.0 [125]	. . .	. . .	. . .
83	341	. . .	. . .	. . .	. . .	3.0 [75]	3.0 [75]	. . .
84	341	. . .	. . .	6.0 [150]	. . .	. . .	. . .	. . .
85	321	. . .	. . .	10.0 [250]	. . .	. . .	. . .	. . .

TABLE 4 Chemical Requirements

Elements	Composition, %													
	min	max	min	max	min	max	min	max	min	max	min	max	min	max
Grade	11		12		12a		13		21		22		23	
Carbon	0.23	0.28	. . .	0.12	. . .	0.20	0.27	0.33	0.31	0.38	0.38	0.43	0.45	0.50
Manganese	. . .	0.20	0.60	0.90	0.60	0.90	0.40	0.60	0.60	0.90	0.60	0.90	0.60	0.90
Phosphorus	. . .	0.01	. . .	0.010	. . .	0.015	. . .	0.025	. . .	0.025	. . .	0.025	. . .	0.015
Sulfur	. . .	0.01	. . .	0.010	. . .	0.015	. . .	0.025	. . .	0.025	. . .	0.025	. . .	0.015
Silicon	. . .	0.10	0.20	0.35	0.20	0.35	0.20	0.35	0.20	0.35	0.20	0.35	0.15	0.30
Nickel	2.75	3.25	4.75	5.25	4.75	5.25	. . .	. . .	1.65	2.00	1.65	2.00	0.40	0.70
Chromium	1.40	1.65	0.40	0.70	0.40	0.70	0.80	1.10	0.65	0.90	0.70	0.90	0.90	1.20
Molybdenum	0.8	1.0	0.30	0.65	0.30	0.65	0.15	0.25	0.30	0.60	0.30	0.60	0.90	1.10
Vanadium	. . .	. . .	0.05	0.10	0.05	0.10	0.05	0.10	0.17	0.23	0.05	0.10	0.08	0.15
Niobium/ Columbium[A]	0.03	0.07	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Grade	31		32		33		41		51		52		53[B]	
Carbon	0.23	0.28	0.40	0.45	0.41	0.46	0.38	0.43	. . .	0.15	0.20	0.25	. . .	0.20
Manganese	1.20	1.50	0.65	0.90	0.75	1.00	0.20	0.40	. . .	1.00	0.50	1.00	. . .	1.00
Phosphorus	. . .	0.025	. . .	0.025	. . .	0.025	. . .	0.015	. . .	0.025	. . .	0.025	. . .	0.025
Sulfur	. . .	0.025	. . .	0.025	. . .	0.025	. . .	0.015	. . .	0.025	. . .	0.025	. . .	0.025
Silicon	1.30	1.70	1.45	1.80	1.40	1.75	0.80	1.00	. . .	1.00	. . .	0.50	. . .	1.00
Nickel	1.65	2.00	1.65	2.00	. . .	. . .	. . .	. . .	. . .	0.75	0.50	1.00	1.25	2.50
Chromium	0.20	0.40	0.65	0.90	1.90	2.25	4.75	5.25	11.5	13.5	11.0	12.5	15.0	17.0
Molybdenum	0.35	0.45	0.30	0.45	0.45	0.60	1.20	1.40	. . .	0.50	0.90	1.25	. . .	. . .
Copper	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.50	. . .	. . .	. . .	. . .
Titanium	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.05	. . .	. . .
Vanadium	. . .	. . .	. . .	. . .	0.03	0.08	0.40	0.60	. . .	. . .	0.20	0.30	. . .	. . .
Cobalt	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.25	. . .	. . .
Aluminum	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.05	. . .	0.05	. . .	. . .
Tungsten	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.90	1.25	. . .	. . .
Tin	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.05	. . .	0.04	. . .	. . .
Grade	61[B,C]		62[B,C]		63[B,C]		64[B,C]		71[B,C]		72[B,C]		73[B,C]	
Carbon	. . .	0.07	. . .	0.09	. . .	0.09	0.10	0.15	. . .	0.03	. . .	0.03	. . .	0.03
Manganese	. . .	1.00	. . .	1.00	. . .	1.00	0.50	1.25	. . .	0.10	. . .	0.10	. . .	0.10
Phosphorus	. . .	0.025	. . .	0.025	. . .	0.025	. . .	0.025	. . .	0.01	. . .	0.01	. . .	0.01
Sulfur	. . .	0.025	. . .	0.025	. . .	0.025	. . .	0.025	. . .	0.01	. . .	0.01	. . .	0.01
Silicon	. . .	1.00	. . .	1.00	. . .	0.50	. . .	0.50	. . .	0.10	. . .	0.10	. . .	0.10
Nickel	3.0	5.0	6.5	7.75	6.5	7.75	4.0	5.0	17.0	19.0	17.0	19.0	18.0	19.0
Chromium	15.5	17.5	16.0	18.0	14.0	15.25	15.0	16.0	. . .	. . .	. . .	. . .	. . .	. . .
Molybdenum	. . .	. . .	. . .	. . .	2.0	2.75	2.50	3.25	3.0	3.5	4.6	5.2	4.6	5.2
Copper	3.0	5.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Titanium	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.15	0.25	0.30	0.50	0.50	0.80
Columbium	0.15	0.45	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Cobalt	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	8.0	9.0	7.0	8.5	8.5	9.5
Aluminum	. . .	. . .	0.75	1.50	0.75	1.25	. . .	. . .	0.05	0.15	0.05	0.15	0.05	0.15
Nitrogen	. . .	. . .	. . .	. . .	. . .	. . .	0.07	0.13	. . .	. . .	. . .	. . .	. . .	. . .
Grade	74[B,C]		75[B,C]		81[B,C]		82[B,C]		83[B,C]		84[B,C]		85	
Carbon	. . .	0.03	. . .	0.03	0.24	0.30	0.28	0.34	0.42	0.47	0.16	0.23	0.20	0.25
Manganese	. . .	0.10	. . .	0.10	0.10	0.35	0.10	0.35	0.10	0.35	0.20	0.40	1.75	2.25
Phosphorus	. . .	0.01	. . .	0.01	. . .	0.01	. . .	0.01	. . .	0.01	. . .	0.010	. . .	0.025
Sulfur	. . .	0.01	. . .	0.01	. . .	0.01	. . .	0.01	. . .	0.01	. . .	0.005	. . .	0.025
Silicon	. . .	0.12	. . .	0.12	. . .	0.10	. . .	0.10	. . .	0.10	. . .	0.20	0.75	1.10
Nickel	11.5	12.5	11.5	12.5	7.0	9.0	7.0	8.5	7.0	8.5	8.5	9.5	0.50	0.90
Chromium	4.75	5.25	4.75	5.25	0.35	0.60	0.90	1.10	0.20	0.35	0.65	0.85	1.90	2.35
Molybdenum	2.75	3.25	2.75	3.25	0.35	0.60	0.90	1.10	0.20	0.35	0.95	1.10	0.10	0.25
Titanium	0.05	0.15	0.10	0.25	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.05
Vanadium	. . .	. . .	. . .	. . .	0.06	0.12	0.06	0.12	0.06	0.12	0.06	0.15	0.20	0.45
Cobalt	. . .	. . .	. . .	. . .	3.5	4.5	4.0	5.0	3.5	4.5	4.25	4.75	. . .	0.25
Aluminum	0.25	0.40	0.35	0.50	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.020	. . .	0.50
Copper	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.40	0.70

[A] Columbium and Niobium may be used interchangeably.
[B] Product analysis of sulfur and phosphorus shall conform to the requirements of Table 4.
[C] 0.06 calcium, 0.003 boron, and 0.02 zirconium may be added.

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 3*T* 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:*

6.5.2.1 For quenched and tempered forgings weighing 5000 lb [2250 kg] or less at the time of heat treatment, but not exceeding 12 ft [3.7 m] in length, 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.

6.5.2.2 For quenched and tempered forgings and forged bars weighing over 5000 lb [2250 kg] to 10 000 lb [4500 kg] at the time of heat treatment, but not exceeding 12 ft [3.7 m] in length, one tension test shall be taken from each forging.

6.5.2.3 For quenched and tempered forgings and forged bars that exceed 12 ft [3.7 m] in length, one tension test shall be taken from each end of each forging.

6.5.2.4 For quenched and tempered forgings and forged bars weighing more than 10 000 lb [4500 kg] at the time of heat treatment, two tension tests shall be taken from each forging. These shall be offset 180° from each other except that when the length, excluding test prolongations, exceeds three times the diameter or equivalent thickness, one test shall be taken from each end of the forging and shall be oriented 180° apart. In the case of circular forgings, the diameter is the largest diameter of the forging, excluding flanges. For other configurations, the term equivalent thickness is the maximum diagonal or major axis of the cross-section.

7. Nondestructive Test Requirements

7.1 *General*—The forgings shall be free from cracks, seams, laps, shrinkage, and other injurious discontinuities.

7.2 *Magnetic Particle Inspection*—All ferromagnetic forgings produced to this specification shall be subject to magnetic particle inspection in accordance with Practice A275/A275M by the supplier, unless otherwise specified.

7.2.1 The purchaser may specify Supplementary Requirement S18 from Specification A788/A788M for acceptance criteria.

7.3 *Liquid Penetrant Inspection*—All nonmagnetic forgings produced to this specification shall be subject to liquid penetrant inspection in accordance with Practice E165/E165M, unless otherwise specified.

7.3.1 The purchaser may specify Supplementary Requirement S19 from Specification A788/A788M for acceptance criteria.

7.4 *Ultrasonic Inspection*—All forgings produced to this specification shall be subject to ultrasonic inspection in accordance with Practice A388/A388M, unless otherwise specified.

7.4.1 The purchaser may specify Supplementary Requirement S20 from Specification A788/A788M for acceptance criteria.

8. Repair Welding

8.1 Repair welding of forgings is permissible only at option of the purchaser.

9. Product Marking

9.1 When die stamping is not permitted by the purchaser, electric pencil marking or electroetching may be used.

10. Keywords

10.1 alloy steel forgings; superstrength

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements shall apply only when specified by the purchaser in the inquiry, contract, and order. Details of these supplementary requirements shall be agreed upon by the manufacturer and the purchaser.

S1. Charpy V-Notch Impact Transition Curve

S1.1 Sufficient impact tests shall be made from the forging test material to establish a transition temperature curve based upon one or several of the following criteria:

S1.1.1 Absorbed energy (ft·lbf [J]),

S1.1.2 Fracture appearance (see Supplement 5 of Test Methods and Definitions A370), or

S1.1.3 Lateral expansion.

S1.2 The purchaser shall furnish the manufacturer with details of sample location, number of specimens, heat treatments, and information to be derived from the test.

S2. Alternative Sampling, Specimen Orientation, and Mechanical Property Requirements or Section Sizes, or Both

S2.1 Alternative methods of sampling or specimen orientation and location, and alternative mechanical properties or section sizes, or both, not covered by this specification may be established by agreement between manufacturer and purchaser.

S3. Macroetch Tests

S3.1 Macroetchings shall be made from the ends of each billet representing the top and bottom of each ingot unless otherwise specified. If forgings are produced directly from ingot form, or if billet macroetchings are impractical, etchings from the top and bottom of each ingot or full section slices from those forgings representing the top and bottom of each ingot are acceptable by agreement between manufacturer and purchaser.

S3.2 The purchaser shall specify whether photomacrographs are required.

S4. Microcleanliness

S4.1 Microcleanliness testing shall be performed in accordance with Test Methods E45. The purchaser shall furnish all necessary information relating to method of sampling and rating, along with acceptance criteria.

S5. Grain Size

S5.1 Grain size shall be determined in accordance with Test Methods E112. The purchaser shall include all necessary information relating to procedure and required grain size limits.

S5.2 Specimen preparation shall be in accordance with Guide E3.

S6. Decarburization

S6.1 When decarburization testing is specified, the purchaser shall include the following information:

S6.1.1 Number of samples,

S6.1.2 Sample location,

S6.1.3 Decarburization depth limits, if any, and

S6.1.4 Any special metallographic preparation, etching, or rating procedures.

S6.2. Specimens for decarburization ratings shall be prepared in accordance with Guide E3.

S6.3 This test is usually only applicable to grades which are prone to decarburization by surface oxidation occurring either in forging to close tolerances over finish sizes or in heat treating the finish machined parts.

S7. Fracture Toughness

S7.1 The procedure for establishing fracture toughness including type and size of specimens, testing procedure, and limiting values shall be established by agreement between manufacturer and purchaser.

S8. Cryogenic and Elevated Temperature Properties

S8.1 When mechanical property testing at other than ambient temperature is specified, the details of the testing procedure, including type and size of specimens, testing temperatures, and limiting values, shall be established by agreement between manufacturer and purchaser.

S8.2 Short Time Elevated Temperature Tension Tests shall be in accordance with Test Methods E21.

S9. Hardenability

S9.1 Hardenability testing shall be in accordance with Test Methods A255, unless otherwise specified.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A579/A579M–04a(2014)) that may impact the use of this standard.

(1) In 1.3, increased number of grades.
(2) In Table 1, added new Grade 85 tensile requirements.
(3) In Table 2, added new Grade 85 impact toughness requirements.
(4) In Table 3, added new Grade 85 yield strength class requirements.
(5) In Table 4, added new Grade 85 chemical requirements and footnote about Niobium/Columbium per new A01 format.