



Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings¹

This standard is issued under the fixed designation B247; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification² covers aluminum-alloy (**Note 1**) die forgings, hand forgings, and rolled ring forgings as shown in **Table 2**, **Table 3** and **Table 4** in **Section 10** for heat-treatable alloy forgings supplied in the F and O1 tempers. The maximum thicknesses for forgings within the scope of this specification are as indicated in those tables.

NOTE 1—Throughout this specification use of the term *alloy* in the general sense includes aluminum as well as aluminum alloy.

NOTE 2—For forging stock supplied as rolled or cold-finished bar or rod see Specification **B211**. For forging stock supplied as extruded bar or rod see Specification **B221**.

1.2 Alloy and temper designations are in accordance with ANSI H35.1/H35.1(M). The equivalent Unified Numbering System alloy designations are those of **Table 1** preceded by A9, for example, A91100 for aluminum 1100 in accordance with Practice **E527**.

1.3 For acceptance criteria for inclusion of new aluminum and aluminum alloys in this specification, see **Annex A2**.

1.4 This specification is the inch-pound companion to Specification B247M; therefore, no SI equivalents are presented in the specification.

2. Referenced Documents

2.1 The following documents of the issue in effect on date of material purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards*:³

¹ This specification is under the jurisdiction of ASTM Committee **B07** on Light Metals and Alloys and is the direct responsibility of Subcommittee **B07.03** on Aluminum Alloy Wrought Products.

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² For ASME Boiler and Pressure Vessel Code applications see related Specification SB-247 in Section II of that Code.

³ 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.

B211 Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire

B221 Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products

B594 Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products

B660 Practices for Packaging/Packing of Aluminum and Magnesium Products

B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products

B918 Practice for Heat Treatment of Wrought Aluminum Alloys

B985 Practice for Sampling Aluminum Ingots, Billets, Castings and Finished or Semi-Finished Wrought Aluminum Products for Compositional Analysis

E10 Test Method for Brinell Hardness of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys

E165 Practice for Liquid Penetrant Examination for General Industry

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

E607 Test Method for Atomic Emission Spectrometric Analysis Aluminum Alloys by the Point to Plane Technique Nitrogen Atmosphere (Withdrawn 2011)⁴

E716 Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spectrochemical Analysis

E1004 Test Method for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method

E1251 Test Method for Analysis of Aluminum and Aluminum Alloys by Spark Atomic Emission Spectrometry

⁴ The last approved version of this historical standard is referenced on www.astm.org.

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

TABLE 1 Chemical Composition Limits^{A,B,C,J}

Alloy	Silicon	Iron	Copper	Man- ganese	Mag- nesium	Chro- mium	Nickel	Zinc	Titanium	Zir- conium	Other Elements ^D		Alumi- num
											Each	Total ^E	
1100	0.95 Si + Fe		0.05–0.20	0.05	...	...	...	0.10	...	...	0.05	0.15	99.00 min ^F
2014	0.50–1.2	0.7	3.9–5.0	0.40–1.2	0.20–0.8	0.10	...	0.25	0.15	...	0.05	0.15	rem
2018	0.9	1.0	3.5–4.5	0.20	0.45–0.9	0.10	1.7–2.3	0.25	...	...	0.05	0.15	rem
2025	0.50–1.2	1.0	3.9–5.0	0.40–1.2	0.05	0.10	...	0.25	0.15	...	0.05	0.15	rem
2218	0.9	1.0	3.5–4.5	0.20	1.2–1.8	0.10	1.7–2.3	0.25	...	...	0.05	0.15	rem
2219	0.20	0.30	5.8–6.8	0.20–0.40	0.02	...	...	0.10	0.02–0.10	0.10–0.25	0.05	0.15	rem
2618	0.10–0.25	0.9–1.3	1.9–2.7	...	1.3–1.8	...	0.9–1.2	0.10	0.04–0.10	...	0.05	0.15	rem
3003	0.6	0.7	0.05–0.20	1.0–1.5	...	...	...	0.10	...	...	0.05	0.15	rem
4032	11.0–13.5	1.0	0.50–1.3	...	0.8–1.3	0.10	0.50–1.3	0.25	...	...	0.05	0.15	rem
5083	0.40	0.40	0.10	0.40–1.0	4.0–4.9	0.05–0.25	...	0.25	0.15	...	0.05	0.15	rem
6061	0.40–0.8	0.7	0.15–0.40	0.15	0.8–1.2	0.04–0.35	...	0.25	0.15	...	0.05	0.15	rem
6066	0.9–1.8	0.50	0.7–1.2	0.6–1.1	0.8–1.4	0.40	...	0.25	0.20	...	0.05	0.15	rem
6151	0.6–1.2	1.0	0.35	0.20	0.45–0.8	0.15–0.35	...	0.25	0.15	...	0.05	0.15	rem
7049	0.25	0.35	1.2–1.9	0.20	2.0–2.9	0.10–0.22	...	7.2–8.2	0.10	...	0.05	0.15	rem
7050	0.12	0.15	2.0–2.6	0.10	1.9–2.6	0.04	...	5.7–6.7	0.06	0.08–0.15	0.05	0.15	rem
7075	0.40	0.50	1.2–2.0	0.30	2.1–2.9	0.18–0.28	...	5.1–6.1	0.20 ^I	...	0.05	0.15	rem
7076	0.40	0.6	0.30–1.0	0.30–0.8	1.2–2.0	...	...	7.0–8.0	0.20	...	0.05	0.15	rem
7175	0.15	0.20	1.2–2.0	0.10	2.1–2.9	0.18–0.28	...	5.1–6.1	0.10	...	0.05	0.15	rem

^A Limits are in weight percent maximum unless shown as a range or stated otherwise.

^B Analysis shall be made for the elements for which limits are shown in this table.

^C For purposes of determining conformance to these limits, an observed value or a calculated value obtained from analysis shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the specified limit, in accordance with the rounding-off method of Practice E29.

^D *Others* includes listed elements for which no specific limit is shown as well as unlisted metallic elements. The producer may analyze samples for trace elements not specified in the specification. However, such analysis is not required and may not cover all metallic *Others* elements. Should any analysis by the producer or the purchaser establish that an *Others* element exceeds the limit of *Each* or that the aggregate of several *Others* elements exceeds the limit of *Total*, the material shall be considered nonconforming.

^E *Other Elements*—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.

^F The aluminum content shall be calculated by subtracting from 100.00 % the sum of all metallic elements present in amounts of 0.010 % or more each, rounded to the second decimal before determining the sum.

^G Upon agreement between purchaser and producer or supplier, a zirconium-plus-titanium limit of 0.20 % maximum is permitted.

^H Vanadium, 0.05–0.15 %. The total for other elements does not include Vanadium.

^I Upon agreement between purchaser and producer or supplier, a zirconium-plus-titanium limit of 0.25 % maximum is permitted.

^J In case there is a discrepancy in the values listed in Table 1 with those listed in the "International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys" (known as the "Teal Sheets"), the composition limits registered with the Aluminum Association and published in the "Teal Sheets" shall be considered the controlling composition. The "Teal Sheets" are available at <http://www.aluminum.org/tealsheets>.

G47 Test Method for Determining Susceptibility to Stress-Corrosion Cracking of 2XXX and 7XXX Aluminum Alloy Products

2.3 ANSI Standard:

H35.1/H35.1(M) Alloy and Temper Designation Systems⁵

2.4 Military Standards:

MIL-STD-129 Marking for Shipment and Storage⁶ (referenced in MIL-STD-649 and applies only to direct shipments to Department of Defense agencies).

2.5 SAE:

AMS 2772 Heat Treatment of Aluminum Alloys Raw Materials⁷

2.6 Federal Standard:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)⁶

2.7 National Aerospace Standard:

NAS 410 Certification and Qualification of Nondestructive Test Personnel⁸

2.8 Other Standards:

CEN EN 14242 Aluminum and aluminum alloys. Chemical Analysis. Inductively coupled plasma optical emission spectral analysis⁹

3. Terminology

3.1 Definitions:

3.1.1 Refer to Terminology B881 for definitions of product terms used in this specification.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *capable of*—The term *capable of* as used in this specification means that the test need not be performed by the producer of the material. However, should subsequent testing by the purchaser establish that the material does not meet the requirements, the material shall be subject to rejection.

4. Ordering Information

4.1 Orders for material to this specification shall include the following information:

4.1.1 This specification designation (which includes the number, the year, and the revision letter, if applicable),

4.1.2 Quantity in pieces or pounds,

4.1.3 Alloy (Section 7),

⁵ Available from Aluminum Association, Inc., 1400 Crystal Dr. Blvd., Suite 430, Arlington, VA 22202, <http://www.aluminum.org>.

⁶ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

⁷ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

⁸ Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, <http://www.aia-aerospace.org>.

⁹ Available from European Committee for Standardization, Central Secretariat (CEN), rue de Stassart 36, B1050 Brussels, Belgium, <http://www.cen.eu/esearch>.

TABLE 2 Mechanical Property Limits for Die Forgings^{A,B}

Alloy and Temper	Specified Thick- ness, in.	Specimen Axis Parallel to Direction of Grain Flow ^C				Specimen Axis Not Parallel to Direction of Grain Flow ^C			Brinell Hard- ness ^D , min
		Tensile Strength ^E , min, ksi	Yield Strength ^E (0.2 % Offset), min, ksi	Elongation ^E in 2 in. or 4 x Dia, min, %		Tensile Strength ^E , min, ksi	Yield Strength ^E (0.2 % Offset), min, ksi	Elongation ^E in 2 in. or 4 x Dia., min, % Forgings	
				Forgings	Separate Test Coupon (from stock or forged) ^F				
1100-H112	up through 4.000	11.0	4.0	18	25	...	...	...	20
2014-T4	up through 4.000	55.0	30.0	11	16	...	...	...	100
2014-T6	up through 1.000	65.0	56.0	6	8	64.0	55.0	3	125
	1.001–2.000	65.0	56.0	6	...	64.0	55.0	2	125
	2.001–3.000	65.0	55.0	6	...	63.0	54.0	2	125
	3.001–4.000	63.0	55.0	6	...	63.0	54.0	2	125
2018-T61	up through 4.000	55.0	40.0	7	10	...	...	...	100
2025-T6	up through 4.000	52.0	33.0	11	16	...	...	...	100
2218-T61	up through 4.000	55.0	40.0	7	10	...	...	...	100
2219-T6	up through 4.000	58.0	38.0	8	10	56.0	36.0	4	100
2618-T61	up through 4.000	58.0	45.0	4	6	55.0	42.0	4	115
3003-H112	up through 4.000	14.0	5.0	18	25	...	...	...	25
4032-T6	up through 4.000	52.0	42.0	3	5	...	...	...	115
5083-H111	up through 4.000	42.0	22.0	14	14	39.0	20.0	12	...
5083-H112	up through 4.000	40.0	18.0	16	16	39.0	16.0	14	...
6061-T6	up through 4.000	38.0	35.0	7	10	38.0	35.0	5	80
6066-T6	up through 4.000	50.0	45.0	8	12	...	...	...	100
6151-T6	up through 4.000	44.0	37.0	10	14	44.0	37.0	6	90
7049-T73	up through 1.000	72.0	62.0	7	10	71.0	61.0	3	135
	1.001–2.000	72.0	62.0	7	10	70.0	60.0	3	135
	2.001–3.000	71.0	61.0	7	10	70.0	60.0	3	135
	3.001–4.000	71.0	61.0	7	10	70.0	60.0	2	135
	4.001–5.000	70.0	60.0	7	10	68.0	58.0	2	135
7050-T74 ^G	up through 2.000	72.0	62.0	7	10	68.0	56.0	5	135
	2.001–4.000	71.0	61.0	7	10	67.0	55.0	4	135
	4.001–5.000	70.0	60.0	7	10	66.0	54.0	3	135
	5.001–6.000	70.0	59.0	7	10	66.0	54.0	3	135
7075-T6	up through 1.000	75.0	64.0	7	10	71.0	61.0	3	135
	1.001–2.000	74.0	63.0	7	...	71.0	61.0	3	135
	2.001–3.000	74.0	63.0	7	...	70.0	60.0	3	135
	3.001–4.000	73.0	62.0	7	...	70.0	60.0	2	135
7075-T73	up through 3.000	66.0	56.0	7	...	62.0	53.0	3	125
	3.001–4.000	64.0	55.0	7	...	61.0	52.0	2	125
7075-T7352	up through 3.000	66.0	56.0	7	...	62.0	51.0	3	125
	3.001–4.000	64.0	53.0	7	...	61.0	49.0	2	125
7076-T61	up through 4.000	70.0	60.0	10	14	67.0	58.0	3	140
7175-T74 ^G	up through 3.000	76.0	66.0	7	10	71.0	62.0	4	...
7175- T7452 ^G	up through 3.000	73.0	63.0	7	10	68.0	55.0	4	...

TABLE 2 *Continued*

Alloy and Temper	Specified Thick- ness, in.	Specimen Axis Parallel to Direction of Grain Flow ^C				Specimen Axis Not Parallel to Direction of Grain Flow ^C			Brinell Hard- ness ^D , min
		Tensile Strength ^E , min, ksi	Yield Strength ^E (0.2 % Offset), min, ksi	Elongation ^E in 2 in. or 4 × Dia, min, %		Tensile Strength ^E , min, ksi	Yield Strength ^E (0.2 % Offset), min, ksi	Elongation ^E in 2 in. or 4 × Dia., min, % Forgings	
				Forgings	Separate Test Coupon (from stock or forged) ^F				
7175- T7454 ^G	up through 3.000	75.0	65.0	7	10	70.0	61.0	4	...

^A To determine conformance to this specification, each value for tensile strength and yield strength shall be rounded to the nearest 0.1 ksi and each value for elongation to the nearest 0.5 % (or the nearest 0.1 % if measured in accordance with 7.8.4 of Test Methods B557), in accordance with the rounding-off method of Practice E29.

^B For the basis for establishment of strength property limits, see Annex A1.

^C These values apply to standard specimens. For the heat-treatable alloys the thicknesses shown are the maximum thickness at time of heat treatment for which the indicated properties apply. Forgings machined prior to heat treatment shall develop the properties applicable to the heat-treated thickness provided the as-forged thickness is not more than twice the heat-treated thickness.

^D For information only. The hardness is usually measured on the surface of a forging using a 500-kgf load and 10-mm ball.

^E Tensile property test requirements in any direction are limited to a minimum material dimension of 2.000 in. because of the difficulty to obtain a tension test specimen suitable for routine control testing.

^F These values apply to standard ½-in. diameter test specimens machined from the stock used in making the forgings, or from separately forged coupons representative of the forgings.

^G Beginning with the 1985 issue the T736, T73652, and T73654 tempers were replaced by the T74, T7452, and T7454 tempers respectively as applicable to alloys 7050 and 7175.

4.1.4 Temper (Section 8),

4.1.5 Dimensions (Section 13). A drawing is required for die forgings and for hand forgings whose shapes are not simple rectangles,

4.2 Additionally, orders for material to this specification shall include the following information when required by the purchaser:

4.2.1 For die forgings, whether tensile property and grain flow survey shall be made (8.2.1.1),

4.2.2 For die forgings, whether tension tests are required using specimens not parallel to the direction of grain flow and whether such test specimens shall be prepared by a specific method (8.3.1),

4.2.3 For hand forgings, whether tension tests shall be made in other than the long transverse and short transverse directions (8.3.3),

4.2.4 For rolled ring forgings, whether tension tests shall be made in the radial direction (8.3.4),

4.2.5 Whether it is required in tension tests that small elongations shall be measured by a special procedure (8.4.2),

4.2.6 Whether heat treatment in accordance with Practice B918 is required (9.2),

4.2.7 Whether 7075-F material shall meet the requirements for T73 temper (10.3),

4.2.8 Whether ultrasonic inspection is required (Section 14 and Table 4),

4.2.9 Whether liquid-penetrant inspection is required (15.3),

4.2.10 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 16),

4.2.11 Whether certification is required (Section 18),

4.2.12 Whether hand forgings shall be marked for identification (Section 19), and

4.2.13 Whether Practices B660 applies and, if so, the levels of preservation, packaging, and packing required (Section 20).

5. Materials and Manufacture

5.1 The forgings may be manufactured by pressing, hammering, or rolling at the option of the producer.

6. Responsibility for Quality Assurance

6.1 *Responsibility for Inspection and Tests*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use their own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser in the order or at the time of contract signing. The purchaser shall have the right to perform any of the inspection and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

6.2 *Lot Definition*—An inspection lot shall be defined as follows:

6.2.1 For heat-treated tempers, an inspection lot shall consist of forgings of the same shape, or a group of forgings of similar size and shape, of the same alloy and heat-treated in the same furnace charge. If forgings are heat-treated in a continuous furnace, forgings charged consecutively during continuous operation of the furnace shall be considered a furnace charge;

TABLE 3 Mechanical Property Limits for Rolled Ring Forgings^{A,B,C}

Alloy and Temper	Maximum Heat Treat Section Thickness, in.	Direction	Tensile Strength, min, ksi ^D	Yield Strength (0.2 % Offset), min, ksi ^D	Elongation in 2 in. or 4 × Diameter, min, %
2014-T6 and 2014-T652 ^E	up through 2.500	tangential	65.0	55.0	7
		axial	62.0	55.0	3
		radial ^F	60.0	52.0	2
	2.501 to 3.000	tangential	65.0	55.0	6
		axial	62.0	52.0	2
		radial ^F	...	...	...
2219-T6	up through 2.500	tangential	56.0	40.0	6
		axial	55.0	37.0	4
		radial ^F	53.0	35.0	2
2618-T61	up through 2.500	tangential	55.0	41.0	6
		axial	55.0	41.0	5
		radial ^F	...	...	...
6061-T6 and 6061-T652 ^E	up through 2.500	tangential	38.0	35.0	10
		axial	38.0	35.0	8
		radial ^F	37.0	33.0	5
	2.501 to 3.500	tangential	38.0	35.0	8
		axial	38.0	35.0	6
		radial ^F	37.0	33.0	4
6151-T6 and 6151-T652 ^E	up through 2.500	tangential	44.0	37.0	5
		axial	44.0	35.0	4
		radial ^F	42.0	35.0	2
7075-T6 and 7075-T652 ^E	up through 2.000	tangential	73.0	62.0	7
		axial	72.0	61.0	3
		radial ^F	68.0	58.0	2
	2.001 to 3.500	tangential	71.0	60.0	6
		axial	70.0	59.0	3
		radial ^F	...	...	...

^A To determine conformance to this specification each value for tensile strength and yield strength shall be rounded to the nearest 0.1 ksi and each value for elongation to the nearest 0.5 % (or the nearest 0.1 % if measured in accordance with 7.8.4 of Test Methods B557), in accordance with the rounding-off method of Practice E29.

^B Tensile property test requirements in any direction are limited to a minimum material dimension of 2.000 in. because of the difficulty to obtain a tension test specimen suitable for routine control testing.

^C Applicable only to rings which have an OD-to-wall thickness ratio of 10/1 or greater. Those having a smaller ratio shall be the subject of agreement between the purchaser and producer.

^D The basis for establishment of mechanical property limits is shown in Annex A1.

^E Forgings may be available in the T651 temper but shall be the subject of agreement between the purchaser and producer.

^F Radial properties are not specified requirements. For wall thicknesses 2 in. and greater, they will be determined when specifically requested for informational purposes only.

TABLE 4 Ultrasonic Discontinuity Limits for Die and Hand Forgings^A

Alloy	Thickness, in.	Product	Maximum Weight per Piece, lb	Discontinuity Class ^B
2014	0.500–4.000	die forgings	300	B
2219	0.500–4.000			
7049	0.500–4.000			
7050	0.500–4.000			
7075	0.500–4.000			
7175	0.500–4.000			
2014	1.000–8.000	hand forgings	600	A
2219	1.000–8.000			
7049	1.000–8.000			
7050	1.000–8.000			
7075	1.000–8.000			
7175	1.000–8.000			

^A Discontinuities in excess of those listed in this table shall be allowed if it is established that they will be removed by machining or that they are in noncritical areas.

^B The discontinuity class limits are defined in Section 11 of Practice B594.

for such forgings weighing 5 lb or less the maximum weight of a lot shall be 2000 lb, and for heavier forgings it shall be 6000 lb.

6.2.2 For nonheat-treated tempers, an inspection lot shall consist of an identifiable quantity of forgings of similar size and shape of the same alloy and temper subjected to inspection at one time.

7. Chemical Composition

7.1 *Limits*—The forgings shall conform to the chemical composition limits specified in [Table 1](#). Conformance shall be determined by the producer by taking samples in accordance with [E716](#) when the ingots are poured and analyzing those samples in accordance with Test Methods [E607](#), [E1251](#), [E34](#), or EN 14242. At least one sample shall be taken for each group of ingots poured simultaneously from the same source of molten metal. If the producer has determined the chemical composition during pouring of the ingots, they shall not be required to sample and analyze the finished product.

7.2 If it becomes necessary to analyze forgings for conformance to chemical composition limits, the methods of sampling and methods of analysis shall be as provided in the following:

7.2.1 *Methods of Sampling*—Samples for chemical analysis shall be taken in accordance with [B985](#).

7.2.2 *Methods of Analysis*—Analysis shall be performed in accordance with Test Methods [E607](#), [E1251](#), [E34](#), or EN 14242.

NOTE 3—It is standard practice in the United States aluminum industry to determine conformance to the chemical composition limits prior to further processing of ingots into wrought products. Due to the continuous nature of the process, it is not practical to keep a specific ingot analysis identified with a specific quantity of finished material.

8. Mechanical Properties of Material as Supplied

8.1 *Limits:*

8.1.1 Die forgings shall conform to the tensile requirements in [Table 2](#).

8.1.1.1 Die forgings shall be capable of conforming to the Brinell hardness requirements in [Table 2](#) when measured at or near the surface, except that in case of question the basis for acceptance shall be conformance with the specified minimum tensile requirements of [Table 2](#).

8.1.2 Hand forgings shall conform to the tensile requirements in [Table 5](#).

8.1.3 Rolled ring forgings shall conform to the tensile property requirements in [Table 3](#).

8.2 *Number of Specimens:*

8.2.1 For die forgings, hand forgings, and rolled ring forgings, there shall be at least one tension specimen taken from each lot (see [6.2](#)).

8.2.1.1 For die forgings, when specified, a grain-flow pattern and tensile-property survey shall be made on a forging representative of the first production parts (see [8.3.2](#)). It shall be repeated after any major change in forging technique.

8.3 *Test Specimen:*

8.3.1 For die forgings, unless otherwise specified by the purchaser at the time of placing the order, test specimens shall

be prepared with the axis of the specimen as nearly parallel to the direction of maximum metal flow as possible, and, at the option of the forging producer, by one of the following methods:

8.3.1.1 *Method 1*—Machined from a section of the stock used in making the forgings.

8.3.1.2 *Method 2*—Machined from a coupon forged from the stock.

8.3.1.3 *Method 3*—Machined from a prolongation of the forging.

8.3.1.4 *Method 4*—Machined from one of the forgings in the lot.

NOTE 4—Test specimens obtained by Method 1, 2, or 3 will usually have different properties from those obtained by Method 4. Samples obtained by Methods 1, 2, or 3 indicate only the general strength level of the forging that would be obtained with proper heat treatment.

8.3.1.5 Specimens representing heat-treated forgings shall be heat-treated with the forgings they represent or shall be machined from coupons that have been so treated.

8.3.2 If required, a die forging representative of the first production parts shall be selected after forging techniques have been established, and shall be tested as follows:

8.3.2.1 Tension test specimens shall be taken in two directions: (1) substantially parallel to, and (2) not parallel to the forging flow lines. The locations shall be as indicated on the forging engineering drawing or, if not indicated, from generally representative areas.

8.3.2.2 A sample forging shall be sectioned at the locations of the specimens, to show the grain flow.

8.3.3 For hand forgings, the specimens shall be taken from a prolongation of the forgings or from a forging chosen to represent the lot. Tests will regularly be made only in the long transverse and short transverse directions, but when required by the purchaser tests shall also be made in the longitudinal direction.

8.3.4 For rolled ring forgings, the specimens shall be taken from a prolongation of the forging or from a forging chosen to represent the lot. Unless otherwise specified, rolled ring forging sections shall be taken from an area representative of the center of mass where size permits. Tests will regularly be made only in the tangential and axial directions, but when required by the purchaser tests shall also be made in the radial direction for informational purposes.

8.4 *Test Methods:*

8.4.1 The tension tests shall be made in accordance with Test Method [B557](#).

8.4.2 If required when the specified elongation is less than 3 % and the elongation measured in the usual manner is less than 4 %, the elongation of round tension specimens shall be measured in accordance with 7.8.4 of Test Methods [B557](#).

8.4.3 Brinell hardness tests shall be made in accordance with Test Method [E10](#), by applying a 500-kgf load on a 10-mm ball for 10 to 15 s. Other equivalent combinations of load and ball or alternative methods of testing may be used if desired provided that, in case of dispute, the results secured with the 500-kgf load and 10-mm ball shall be the basis of acceptance.

TABLE 5 Mechanical Property Limits for Hand Forging^{A,B}

Alloy and Temper	Thickness, ^C in.	Direction	Tensile Strength, min, ksi	Yield Strength (0.2 % Offset), min, ksi	Elonga- tion in 2 in. or 4 x Diameter, min, %
2014-T6	up through 2.000	longitudinal	65.0	56.0	8
		long transverse	65.0	56.0	3
	2.001–3.000	longitudinal	64.0	56.0	8
		long transverse	64.0	55.0	3
		short transverse	62.0	55.0	2
	3.001–4.000	longitudinal	63.0	55.0	8
		long transverse	63.0	55.0	3
		short transverse	61.0	54.0	2
	4.001–5.000	longitudinal	62.0	54.0	7
		long transverse	62.0	54.0	2
		short transverse	60.0	53.0	1
	5.001–6.000	longitudinal	61.0	53.0	7
		long transverse	61.0	53.0	2
		short transverse	59.0	53.0	1
	6.001–7.000	longitudinal	60.0	52.0	6
		long transverse	60.0	52.0	2
		short transverse	58.0	52.0	1
	7.001–8.000	longitudinal	59.0	51.0	6
		long transverse	59.0	51.0	2
		short transverse	57.0	51.0	1
2014-T652	up through 2.000	longitudinal	65.0	56.0	8
		long transverse	65.0	56.0	3
	2.001–3.000	longitudinal	64.0	56.0	8
		long transverse	64.0	55.0	3
		short transverse	62.0	52.0	2
	3.001–4.000	longitudinal	63.0	55.0	8
		long transverse	63.0	55.0	3
		short transverse	61.0	51.0	2
	4.001–5.000	longitudinal	62.0	54.0	7
		long transverse	62.0	54.0	2
		short transverse	60.0	50.0	1
	5.001–6.000	longitudinal	61.0	53.0	7
		long transverse	61.0	53.0	2
		short transverse	59.0	50.0	1
	6.001–7.000	longitudinal	60.0	52.0	6
		long transverse	60.0	52.0	2
		short transverse	58.0	49.0	1
	7.001–8.000	longitudinal	59.0	51.0	6
		long transverse	59.0	51.0	2
		short transverse	57.0	48.0	1
2219-T6	up through 4.000	longitudinal	58.0	40.0	6
		long transverse	55.0	37.0	4
		short transverse ^D	53.0	35.0	2
2219-T852	up through 4.000	longitudinal	62.0	50.0	6
		long transverse	62.0	49.0	4
		short transverse ^D	60.0	46.0	3
2618-T61	up through 2.000	longitudinal	58.0	47.0	7
		long transverse	55.0	42.0	5
		short transverse ^D	52.0	42.0	4
	2.001–3.000	longitudinal	57.0	46.0	7
		long transverse	55.0	42.0	5
		short transverse	52.0	42.0	4

TABLE 5 *Continued*

Alloy and Temper	Thickness, ^C in.	Direction	Tensile Strength, min, ksi	Yield Strength (0.2 % Offset), min, ksi	Elonga- tion in 2 in. or 4 × Diameter, min, %
5083-H111	3.001–4.000	longitudinal	56.0	45.0	7
		long transverse	53.0	40.0	5
		short transverse	51.0	39.0	4
	up through 4.000	longitudinal	42.0	22.0	14
		long transverse	39.0	20.0	12
	5083-H112	up through 4.000	longitudinal	40.0	18.0
		long transverse	39.0	16.0	14
6061-T6 or T652	up through 4.000	longitudinal	38.0	35.0	10
		long transverse	38.0	35.0	8
		short transverse ^D	37.0	33.0	5
7049-T73	4.001–8.000	longitudinal	37.0	34.0	8
		long transverse	37.0	34.0	6
		short transverse	35.0	32.0	4
	2.001–3.000	longitudinal	71.0	61.0	9
		long transverse	71.0	59.0	4
		short transverse	69.0	58.0	3
7049-T7352	3.001–4.000	longitudinal	69.0	59.0	8
		long transverse	69.0	57.0	3
		short transverse	67.0	56.0	2
	4.001–5.000	longitudinal	67.0	56.0	7
		long transverse	67.0	56.0	3
		short transverse	66.0	55.0	2
	1.001–3.000	longitudinal	71.0	59.0	9
		long transverse	71.0	57.0	4
		short transverse ^D	69.0	56.0	3
7050-T7452 ^E	3.001–4.000	longitudinal	69.0	57.0	8
		long transverse	69.0	54.0	3
		short transverse	67.0	53.0	2
	4.001–5.000	longitudinal	67.0	54.0	7
		long transverse	67.0	53.0	3
		short transverse	66.0	51.0	2
	up through 2.000	longitudinal	72.0	63.0	9
		long transverse	71.0	61.0	5
	2.001–3.000	longitudinal	72.0	62.0	9
		long transverse	70.0	60.0	5
		short transverse	67.0	55.0	4
	3.001–4.000	longitudinal	71.0	61.0	9
		long transverse	70.0	59.0	5
		short transverse	67.0	55.0	4
	4.001–5.000	longitudinal	70.0	60.0	9
		long transverse	69.0	58.0	4
		short transverse	66.0	54.0	3
	5.001–6.000	longitudinal	69.0	59.0	9
long transverse		68.0	56.0	4	
short transverse		66.0	53.0	3	
6.001–7.000	longitudinal	68.0	58.0	9	
	long transverse	67.0	56.0	4	
	short transverse	65.0	52.0	3	
7.001–8.000	longitudinal	67.0	57.0	9	
	long transverse	66.0	52.0	4	
	short transverse	64.0	50.0	3	
7075-T6	up through 2.000	longitudinal	74.0	63.0	9
		long transverse	73.0	61.0	4

TABLE 5 Continued

Alloy and Temper	Thickness, ^C in.	Direction	Tensile Strength, min, ksi	Yield Strength (0.2 % Offset), min, ksi	Elonga- tion in 2 in. or 4 x Diameter, min, %
7075-T652	2.001–3.000	longitudinal	73.0	61.0	9
		long transverse	71.0	59.0	4
		short transverse	69.0	58.0	3
	3.001–4.000	longitudinal	71.0	60.0	8
		long transverse	70.0	58.0	3
		short transverse	68.0	57.0	2
	4.001–5.000	longitudinal	69.0	58.0	7
		long transverse	68.0	56.0	3
		short transverse	66.0	56.0	2
	5.001–6.000	longitudinal	68.0	56.0	6
		long transverse	66.0	55.0	3
		short transverse	65.0	55.0	2
	up through 2.000	longitudinal	74.0	63.0	9
		long transverse	73.0	61.0	4
	2.001–3.000	longitudinal	73.0	61.0	9
		long transverse	71.0	59.0	4
		short transverse	69.0	57.0	2
	3.001–4.000	longitudinal	71.0	60.0	8
		long transverse	70.0	58.0	3
		short transverse	68.0	56.0	1
7075-T73	4.001–5.000	longitudinal	69.0	58.0	7
		long transverse	68.0	56.0	3
		short transverse	66.0	55.0	1
	5.001–6.000	longitudinal	68.0	56.0	6
		long transverse	66.0	55.0	3
		short transverse	65.0	54.0	1
	up through 3.000	longitudinal	66.0	56.0	7
		long transverse	64.0	54.0	4
		short transverse ^D	61.0	52.0	3
	3.001–4.000	longitudinal	64.0	55.0	7
		long transverse	63.0	53.0	3
		short transverse	60.0	51.0	2
	4.001–5.000	longitudinal	62.0	53.0	7
		long transverse	61.0	51.0	3
		short transverse	58.0	50.0	2
	5.001–6.000	longitudinal	61.0	51.0	6
		long transverse	59.0	50.0	3
		short transverse	57.0	49.0	2
7075-T7352	up through 3.000	longitudinal	66.0	54.0	7
		long transverse	64.0	52.0	4
		short transverse ^D	61.0	50.0	3
	3.001–4.000	longitudinal	64.0	53.0	7
		long transverse	63.0	50.0	3
		short transverse	60.0	48.0	2
	4.001–5.000	longitudinal	62.0	51.0	7
		long transverse	61.0	48.0	3
		short transverse	58.0	46.0	2
	5.001–6.000	longitudinal	61.0	49.0	6
		long transverse	59.0	46.0	3
		short transverse	57.0	44.0	2
7175-T74 ^E	up through 3.000	longitudinal	73.0	63.0	9
		long transverse	71.0	60.0	5
		short transverse ^D	69.0	60.0	4

TABLE 5 *Continued*

Alloy and Temper	Thickness, ^C in.	Direction	Tensile Strength, min, ksi	Yield Strength (0.2 % Offset), min, ksi	Elongation in 2 in. or 4 x Diameter, min, %
7175-T7452 ^E	3.001–4.000	longitudinal	71.0	61.0	9
		long transverse	70.0	58.0	5
		short transverse	68.0	57.0	4
	4.001–5.000	longitudinal	68.0	57.0	8
		long transverse	67.0	56.0	5
		short transverse	66.0	55.0	4
	5.001–6.000	longitudinal	65.0	54.0	8
		long transverse	64.0	52.0	5
		short transverse	63.0	52.0	4
	up through 3.000	longitudinal	71.0	61.0	9
		long transverse	69.0	58.0	5
		short transverse ^D	67.0	54.0	4
	3.001–4.000	longitudinal	68.0	57.0	9
		long transverse	67.0	55.0	5
		short transverse	65.0	51.0	4
	4.001–5.000	longitudinal	65.0	54.0	8
		long transverse	64.0	52.0	5
		short transverse	63.0	49.0	4
	5.001–6.000	longitudinal	63.0	51.0	8
		long transverse	61.0	49.0	5
		short transverse	60.0	46.0	2

^ATo determine conformance to this specification, each value for tensile strength and yield strength shall be rounded to the nearest 0.1 ksi and each value for elongation to the nearest 0.5 % (or the nearest 0.1 % if measured in accordance with 7.8.4 of Test Methods B557), in accordance with the rounding-off method of Practice E29.

^B For the basis for establishment of strength property limits, see Annex A1.

^C Maximum cross-sectional area is 256 in.², except that for 2618-T61 it is 144 in.². Thickness at heat treatment is measured in the short transverse direction and applies to the dimension as-forged and before any machining operation.

^D Tensile properties in any direction are limited to a minimum material dimension of 2.000 in. because of the difficulty to obtain a tensile specimen suitable for routine control testing.

^E Beginning with the 1985 issue the T736 and T73652 tempers were replaced by the T74 and T7452 tempers respectively as applicable to alloys 7050 and 7175.

9. Heat Treatment

9.1 Unless otherwise specified in 9.2, heat treatment for the applicable tempers designated in Tables 2 and 3 shall be in accordance with AMS 2772.

9.2 When specified, heat treatment for the applicable tempers in Tables 2 and 3 shall be in accordance with Practice B918.

10. Producer Confirmation of Heat-Treat Response

10.1 In addition to the requirements of Section 8, die forgings in alloys 2014, 2018, 2025, 2218, 2219, 2618, 4032, 6061, 6066, 6151, 7075, and 7076 produced in the 01 and F tempers (within the size limits specified in Table 2) shall, after proper solution heat treatment and precipitation heat treatment, conform to the tensile properties specified in Table 2 for T6 temper forgings except for 2018, 2218, 2618, and 7076 for which T61 temper requirements apply.

10.2 In addition to the requirements of Section 8, hand forgings in alloys 2014, 2219, 2618, 6061, and 7075 produced in the 01 and F tempers (within the size limits specified in Table 5) shall, after proper solution heat treatment and precipitation heat treatment, conform to the tensile properties specified in Table 5 for T6 temper forgings except for 2618 for which T61 temper requirements apply.

fied in Table 5 for T6 temper forgings except for 2618 for which T61 temper requirements apply.

10.3 Alloy 7049 die and hand forgings in the F and O tempers and, when specified, 7075 die and hand forgings in the 01 and F tempers (within the size limits specified in Tables 2 and 5, respectively) shall, after proper solution heat treatment and precipitation heat treatment, conform to the tensile properties specified in Tables 2 and 5, as applicable for T73 type temper, and Section 12.

10.4 Alloys 7050 and 7175 die and hand forgings in the F and O tempers (within the size limits specified in Tables 2 and 5, respectively) shall, after proper solution heat treatment and precipitation heat treatment, conform to the tensile properties specified in Tables 2 and 5, as applicable for T74 type temper, and Section 12.

10.5 In addition to the requirements of Section 8, rolled ring forgings in alloys 2014, 2219, 2618, 6061, 6151, and 7075 produced in F and 01 tempers (within the size limits specified in Table 3) shall, after proper heat treatment, conform to the tensile properties specified in Table 3 for T6 temper forgings except for 2618 for which T61 temper requirements apply.

10.6 *Number of Specimens*—One specimen from each lot of 01 and F temper die forgings, hand forgings, and rolled ring forgings shall be tested to verify conformance with 10.1 – 10.5, as applicable.

11. Heat-Treatment and Reheat-Treatment Capability

11.1 As-received die and hand forgings in the 01 and F tempers in alloys 2014, 2018, 2025, 2218, 2219, 2618, 4032, 6061, 6066, 6151, 7075, and 7076 (within the size limitations specified in Tables 2 and 5) shall, after proper solution heat treatment and precipitation heat treatment, be capable of conforming to the tensile properties specified in Tables 2 and 5 for the T6 temper except for 2018, 2218, 2618, and 7076 for which T61 temper requirements apply.

11.2 Alloy 7075 die and hand forgings in T6, T652, T73, and T7352 tempers shall, after proper resolution heat treatment and precipitation heat treatment, be capable of conforming to the tensile properties specified in Tables 2 and 5 for the T6 temper.

11.3 Die forgings in alloy 2014-T4 shall, after proper precipitation heat treatment, be capable of conforming to the tensile properties specified in Table 2 for the T6 temper.

11.4 As-received rolled ring forgings in the F and 01 tempers in alloys 2014, 2219, 2618, 6061, 6151, and 7075 (within the size limits specified in Table 3) shall, after proper solution heat treatment and precipitation heat treatment, be capable of conforming to the tensile properties specified in Table 3 for the T6 temper except for 2618 for which T61 temper requirements apply.

12. Stress-Corrosion Resistance

12.1 Alloys 7049 and 7075 in the T73-type tempers and alloys 7050 and 7175 in the T74-type tempers shall be capable

of exhibiting no evidence of stress-corrosion cracking when subjected to the test specified in 12.2.

12.1.1 For lot acceptance purposes, resistance to stress-corrosion cracking of each lot of alloys 7049, 7050, 7075, and 7175 in the applicable tempers shall be established by testing the previously selected tension-test samples to the criteria shown in Table 6.

12.1.2 For surveillance purposes, each month the producer shall perform at least one test for stress-corrosion resistance in accordance with 12.2.2 on each of the applicable alloy-tempers for each thickness range 0.750 in. and over produced that month. Each sample shall be taken from material considered acceptable in accordance with the lot acceptance criteria of Table 6. A minimum of three adjacent replicate specimens shall be taken from each sample and tested. The producer shall maintain records of all lots so tested and make them available for examination at the producer's facility.

12.2 The stress-corrosion cracking test shall be performed on material 0.750 in. and over in thickness as follows:

12.2.1 Specimens shall be stressed in tension in the short transverse direction with respect to grain flow and held at constant strain. The stress level shall be as follows:

12.2.1.1 For T73-type tempers: 75 % of the minimum yield strength or the minimum longitudinal yield strength specified in Table 2 or Table 5 as applicable.

12.2.1.2 For T74-type tempers: 35.0 ksi for die and hand forgings up through 3.000 in., and 50 % of the minimum longitudinal yield strength specified in Table 5 for hand forgings over 3.000 in.

12.2.2 The stress-corrosion test shall be made in accordance with Test Method G47.

TABLE 6 Lot Acceptance Criteria for the Control of Stress-Corrosion Resistance for Alloys 7049 and 7075 in T73 Type Tempers, and Alloys 7050 and 7175 in T74 Type Tempers

Alloy and Temper	Lot Acceptance Criteria		
	Electrical Conductivity % IACS ^A	Level of Mechanical Properties	Lot Acceptance Status
7049-T73 and T7352	40.0 or greater	per specified requirements	acceptable
	38.0 through 39.9	per specified requirements and longitudinal yield strength does not exceed minimum by more than 9.9 ksi	acceptable
	38.0 through 39.9	per specified requirements but longitudinal yield strength exceeds minimum by 10 ksi or more	unacceptable ^B
	less than 38.0	any level	unacceptable ^B
7050-T74 ^C Die forgings and 7050-T7452 ^C Hand forgings	38.0 or greater ^D	per specified requirements and SCF ^E is 32.0 or less	acceptable
	38.0 or greater	per specified requirements but SCF ^E is over 32.0	unacceptable ^B
	less than 38.0	any level	unacceptable ^B
	38.0 or greater	per specified requirements	acceptable
7075-T73 and T7352 and 7175-T74 ^C , T7452 ^C and T7454 ^C	40.0 or greater	per specified requirements	acceptable
	38.0 through 39.9	per specified requirements and longitudinal yield strength does not exceed minimum by more than 11.9 ksi	acceptable
	38.0 through 39.9	per specified requirements but longitudinal yield strength exceeds minimum by 12.0 ksi or more	unacceptable ^B
	less than 38.0	any level	unacceptable ^B

^A Electrical conductivity measurements shall be made on the surface of the tensile sample in accordance with Test Method E1004.

^B Alloy 7049 material in tempers T73 and T7352, alloy 7050 material in tempers T74 and T7452, 7075 in tempers T73 and T7352, and 7175 in tempers T74, T7452, and T7454 when unacceptable in accordance with the lot acceptance criteria, shall be subject to reprocessing by additional precipitation heat treatment or re-solution heat treatment and precipitation heat treatment and retested.

^C Beginning with the 1985 issue the temper designations T736, T73652, and T73654 were replaced by the T74, T7452, and T7454 tempers respectively as applicable to alloys 7050 and 7175.

^D 7050 Die forgings in the T74 temper also are restricted to having yield strength, parallel to the direction of grain flow, not to exceed 72.0 ksi.

^E Stress-Corrosion Susceptibility Factor (SCF) equals yield strength (XX.X ksi) – electrical conductivity (XX.X % IACS).

12.2.3 There shall be no visual evidence of stress-corrosion cracking in any specimen, except that the retest provision of **17.2** shall apply.

13. Dimensional Tolerances

13.1 The forgings shall conform to the shape and dimensions specified in the contract or order within such dimensional tolerances as may be specified in the contract, order, or referenced drawings.

14. Internal Quality

14.1 When specified by the purchaser at the time of placing the order, each die forging not more than 300 lb, in thicknesses 0.500 to 4.000 in., in alloys 2014, 2219, 7049, 7050, 7075, and 7175, and each hand forging not more than 600 lb, in thicknesses 1.000 to 8.000 in., in alloys 2014, 2219, 7049, 7050, 7075, and 7175 shall be tested ultrasonically in accordance with Practice **B594** to the discontinuity acceptance limits of **Table 4**. For rolled ring forgings ultrasonic testing requirements and the applicable discontinuity acceptance limits in accordance with Practice **B594** shall be the subject of agreement between the purchaser and producer.

15. General Quality

15.1 The forgings shall be of uniform quality and condition as defined by the requirements of this specification and shall be commercially sound. Any requirement not so covered shall be subject to agreement between the purchaser and producer.

15.2 *Visual Inspection*—Prior to visual inspection each die forging or rolled ring forging shall be etched in an aqueous solution of sodium hydroxide to provide a surface suitable for visual or penetrant inspection. At the option of the producer, an inhibitor may be used in the sodium hydroxide.

NOTE 5—An inhibitor in the sodium hydroxide solution is desirable to prevent intergranular attack of copper-bearing alloys. A suitable solution consists of 50 g of sodium hydroxide and 2.5 g of sodium sulphide dissolved in 1 L of water. Etching time for this solution when maintained at 150 to 160°F should be 1 min. Other inhibited solutions may be used to provide the same etching effect. Subsequently, the parts shall be thoroughly rinsed in water followed by a wash in nitric acid or a chromic-sulphuric acid solution or any other equivalent solution to produce a surface suitable for visual or penetrant inspection.

15.3 Unless otherwise specified, each etched forging shall be inspected visually for surface defects such as seams, laps, bursts, and quench cracks.

15.3.1 When specified, each etched forging shall be penetrant inspected in accordance with Test Method **E165**, using post-emulsifiable penetrants or water-washable penetrants, for injurious surface defects. Penetrant inspection personnel shall be certified to NDT Level II in accordance with NAS 410.

NOTE 6—All parts or areas of parts to be inspected must be clean and dry before the penetrant is applied.

16. Source Inspection

16.1 If the purchaser desires that his representative inspect or witness the inspection and testing of the forgings prior to shipment, such agreement shall be made by the purchaser and producer as part of the purchase contract.

16.2 When such inspection or witness of inspection and testing is agreed upon the producer shall afford the purchaser's representative all reasonable facilities to satisfy him that the forgings meet the requirements of this specification. Inspection and tests shall be conducted so there is no unnecessary interference with the producer's operations.

17. Retest and Rejection

17.1 If any material fails to conform to all of the applicable requirements of this specification, it shall be cause for rejection of the inspection lot.

17.2 When there is evidence that a failed specimen was not representative of the inspection lot and when no other sampling plan is provided or approved by the purchaser through the contract or purchase order, at least two additional specimens shall be selected to replace each test specimen that failed. All specimens so selected for retest shall meet the requirements of the specification or the lot shall be subject to rejection.

17.3 Material in which defects are discovered subsequent to inspection may be rejected.

17.4 If material is rejected by the purchaser, the producer or supplier is responsible only for replacement of the material to the purchaser. As much as possible of the rejected material shall be returned to the producer or supplier.

18. Certification

18.1 The producer shall, on request, furnish to the purchaser a certificate stating that each lot of forgings has been sampled, tested, and inspected in accordance with this specification and has met the requirements.

19. Identification Marking of Product

19.1 Each die forging shall be identification marked in accordance with the requirements of the forging drawing.

19.2 When specified, hand forgings shall be identification marked with the producer's name or trademark, the applicable alloy and temper designations, and the specification number. Identification characters shall have a minimum height of ¼ in. The marking material shall be such as to resist obliteration during normal handling.

20. Packaging and Package Marking

20.1 The forgings shall be packaged to provide adequate protection during normal handling and transportation and each package shall contain only one size, alloy, and temper of material unless otherwise agreed upon. The type of packaging and gross weight of containers shall, unless otherwise agreed upon, be at the producer's discretion, provided they are such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the delivery point.

20.2 Each shipping container shall be marked with the purchase order number, forging size, specification number, alloy and temper, gross and net weights, and the producer's name or trademark.

20.3 When specified in the contract or purchase order, material shall be preserved, packaged, and packed in accordance with the requirements of Practices **B660**. The applicable

levels shall be as specified in the contract or order. Marking for shipment of such material shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

21. Keywords

21.1 aluminum alloy; die forgings; hand forgings; rolled ring forgings

ANNEXES

(Mandatory Information)

A1. BASIS FOR INCLUSION OF PROPERTY LIMITS

A1.1 Mechanical property limits are established in accord with section 6, Standards Section, of the most current edition of the Aluminum Standards and Data and the latest edition of the Aluminum Association publication “Tempers for Aluminum and Aluminum Alloy Products (Yellow and Tan Sheets)”.

Limits are based on a statistical evaluation of the data indicating that at least 99 % of the population obtained from all standard material meets the limit with 95 % confidence. For the products described, mechanical property limits are based on the statistical analyses of at least 100 tests from at least 5 cast lots of standard production material with no more than 10 observations from a given heat treat or inspection lot. Mechanical properties limits for press solution heat treated products have specific additional requirements which are provided in the “Tempers for Aluminum and Aluminum Alloy Products”.

Limits denoted as “Tentative” by the Aluminum Association may be included. Requirements for tentative property registrations are defined in the latest edition of the Aluminum Association publication “Tempers for Aluminum and Aluminum Alloy Products”. Tentative property limits are established at levels at which at least 99 % of the data conform at a confidence level of 95 %. Tentative property limits, which are subject to revision, shall be based on a statistical analysis of at least 30 tests from at least 3 cast lots of standard production material with no more than 10 observations from a given heat treat or inspection lot. Where tentative property limits are listed, they shall be shown in italics and footnoted as Tentative in the standard.

All tests are performed in accordance with the appropriate ASTM test methods.

A2. ACCEPTANCE CRITERIA FOR INCLUSION OF NEW ALUMINUM AND ALUMINUM ALLOYS IN THIS SPECIFICATION

A2.1 Prior to acceptance for inclusion in this specification, the composition of wrought or cast aluminum or aluminum alloy shall be registered in accordance with ANSI H35.1/H35.1(M). The Aluminum Association Inc.⁵ holds the Secretariat of ANSI H35 Committee and administers the criteria and procedures for registration.

A2.2 If it is documented that The Aluminum Association Inc. could not or would not register a given composition, an alternative procedure and the criteria for acceptance shall be as follows:

A2.2.1 The designation submitted for inclusion does not utilize the same designation system as described in ANSI H35.1/H35.1(M). A designation not in conflict with other designation systems or a trade name is acceptable.

A2.2.2 The aluminum or aluminum alloy has been offered for sale in commercial quantities within the prior twelve months to at least three identifiable users.

A2.2.3 The complete chemical composition limits are submitted.

A2.2.4 The composition is, in the judgment of the responsible subcommittee, significantly different from that of any other aluminum or aluminum alloy already in the specification.

A2.2.5 For codification purposes, an alloying element is any element intentionally added for any purpose other than grain refinement and for which minimum and maximum limits are specified. Unalloyed aluminum contains a minimum of 99.00 % aluminum.

A2.2.6 Standard limits for alloying elements and impurities are expressed to the following decimal places:

Less than 0.001 %	0.000X
0.001 to but less than 0.01 %	0.00X
0.01 to but less than 0.10 %	
Unalloyed aluminum made by a refining process	0.0XX
Alloys and unalloyed aluminum not made by a refining process	0.0X
0.10 through 0.55 %	0.XX
(It is customary to express limits of 0.30 through 0.55 % as 0.X0 or 0.X5.)	
Over 0.55 %	0.X, X.X, etc.
(except that combined Si + Fe limits for 99.00 % minimum aluminum must be expressed as 0.XX or 1.XX)	

A2.2.7 Standard limits for alloying elements and impurities are expressed in the following sequence: Silicon; Iron; Copper; Manganese; Magnesium; Chromium; Nickel; Zinc; Titanium (**Note A2.1**); Other Elements, Each; Other Elements, Total; Aluminum (**Note A2.2**).

NOTE A2.1—Additional specified elements having limits are inserted in alphabetical order of their chemical symbols between Titanium and Other Elements, Each, or are specified in footnotes.

NOTE A2.2—Aluminum is specified as *minimum* for unalloyed aluminum and as a *remainder* for aluminum alloys.

SUMMARY OF CHANGES

Committee B07 has identified the location of selected changes to this standard since the last issue (insert designation and year date) that may impact the use of this standard. (Approved Oct. 1, 2015.)

- (1) Change of address for the Aluminum Association in Footnote 5 (referenced in 2.3).
- (2) Added footnote J to **Table 1**.
- (3) Added references to Practice B985 in Sections 2.2 and 7.2.1.

- (4) Revised **Table 1** to move element Footnotes to one column and abbreviate remainder.
- (5) Revised Section 7 to replace sampling and analysis information with references to Practice B985.
- (6) Revised Section A1.1.

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