Designation: B 247M – 02a

METRIC

Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings [Metric][1]

This standard is issued under the fixed designation B 247M; 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 Department of Defense.

1. Scope *

1.1 This specification covers aluminum-alloy (Note 1) die forgings, hand forgings, and rolled ring forgings as shown in Table 2, Table 3 and Table 4 and in Section 10 for heat-treatable alloy forgings supplied in the F and 01 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 B 211M. For forging stock supplied as extruded bar or rod see Specification B 221M.

1.2 Alloy and temper designations are in accordance with ANSI H35.1M. 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 E 527.

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 metric counterpart of Specification B 247.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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:*

B 211 Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire[2]

B 221 Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wires, Profiles, and Tubes[2]

B 247 Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand-Forgings, and Rolled Ring Forgings[2]

B 557M Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products [Metric][2]

B 594 Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications[2]

B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products[2]

B 881 Terminology Relating to Aluminum- and Magnesium-Alloy Products[2]

B 918 Practice for Heat Treatment of Wrought Aluminum Alloys[2]

E 10 Test Method for Brinell Hardness of Metallic Materials[3]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[4]

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum Base Alloys[5]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[5]

E 165 Practice for Liquid Penetrant Examination[6]

E 527 Practice for Numbering Metals and Alloys (UNS)[7]

E 607 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere[5]

E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis[5]

E 1004 Test Method for Electromagnetic (Eddy Current)

[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] *Annual Book of ASTM Standards*, Vol 02.02.

[3] *Annual Book of ASTM Standards*, Vol 03.01.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] *Annual Book of ASTM Standards*, Vol 03.05.

[6] *Annual Book of ASTM Standards*, Vol 03.03.

[7] *Annual Book of ASTM Standards*, Vol 01.01.

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

TABLE 1 Chemical Composition Limits[A,B,C]

Alloy	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Nickel	Zinc	Zirconium	Titanium	Other Elements[D]		Aluminum, min
											Each	Total[E]	
1100	0.95 Si + Fe		0.05–0.20	0.05	...	...	...	0.10	...	...	0.05	0.15	99.00[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[G]	0.05	0.15	remainder
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	remainder
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	remainder
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	remainder
2219	0.20	0.30	5.8–6.8	0.20–0.40	0.02	...	...	0.10	0.10–0.25	0.02–0.10	0.05[H]	0.15[H]	remainder
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	remainder
3003	0.6	0.7	0.05–0.20	1.0–1.5	...	...	...	0.10	...	...	0.05	0.15	remainder
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	remainder
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	remainder
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	remainder
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	remainder
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	remainder
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	remainder
7050	0.12	0.15	2.0–2.6	0.10	1.9–2.6	0.04	...	5.7–6.7	0.08–0.15	0.06	0.05	0.15	remainder
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	remainder
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	remainder
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	remainder

[A] Limits are in mass 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 E 29.
[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 %.
[I] Upon agreement between purchaser and producer or supplier, a zirconium-plus-titanium limit of 0.25 % maximum is permitted.

Measurements of Electrical Conductivity[6]

E 1251 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Argon Atmosphere, Point-to-Plane, Unipolar Self-Initiating Capacitor Discharge[5]

G 47 Test Method for Determining Susceptibility to Stress-Corrosion Cracking of 2XXX and 7XXX Aluminum Alloy Products[8]

2.3 *ANSI Standard:*

H35.1(M) Alloy and Temper Designation Systems for Aluminum[3]

2.4 *ISO Standards:*

ISO 209-1:1989 Wrought Aluminum and Aluminum Alloys—Chemical Composition and Form of Product[9]

ISO 2107:1983 Aluminum, Magnesium and their Alloys—Temper Designations[9]

2.5 *Military Standards:*

MIL-STD-129 Marking for Shipment and Storage[10] (referenced in MIL-STD-649 and applies only to direct shipments to Department of Defense agencies)

2.6 *SAE:*

AMS 2772 Heat Treatment of Aluminum Alloy Raw Materials[11]

2.7 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[10]

2.8 *National Aerospace Standard:*

NAS 410 Certification and Qualification of Nondestructive Test Personnel[12]

3. Terminology

3.1 *Definitions*—Refer to Terminology B 881 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),

[8] *Annual Book of ASTM Standards*, Vol 03.02.
[9] Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.
[10] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.
[11] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096–0001.
[12] Available from Aerospace Industries Association (AIA), 1250 Eye St., NW, Washington, DC 20005.

TABLE 2 Mechanical Property Limits for Die Forgings[A,B]

Alloy and Temper	Specified Thickness, mm		Specimen Axis Parallel to Direction of Grain Flow[C]					Specimen Axis Not Parallel to Direction of Grain Flow[C]				Brinell Hardness[D], min
					Elongation, min,%							
	Over	Through	Tensile Strength[E], MPa	Yield Strength[E] (0.2 % Offset), min, MPa	Forgings		Separate Test Coupon (from stock or forged)[F]	Tensile Strength[E], min, MPa	Yield Strength[E] (0.2 % Offset), min, MPa	Elongation, min, % Forgings		
					in 50 mm	in 5× Diameter ($5.65\sqrt{A}$)[G]	in 5× Diameter ($5.65\sqrt{A}$)[G]			in 50 mm	in 5× Diameter ($5.65\sqrt{A}$)[G]	
1100-H112	...	100.00	75	30	18	16	22	...	...	...	...	20
2014-T4	...	100.00	380	205	11	9	14	...	...	...	...	100
2014-T6	...	25.00	450	385	6	5	7	440	380	3	2	125
	25.00	50.00	450	385	6	5	...	440	380	2	1	125
	50.00	80.00	450	380	6	5	...	435	370	2	1	125
	80.00	100.00	435	380	6	5	...	435	370	2	1	125
2018-T61	...	100.00	380	275	7	6	9	...	...	...	...	100
2025-T6	...	100.00	360	230	11	9	14	...	...	...	...	100
2218-T61	...	100.00	380	275	7	6	9	...	...	...	...	100
2219-T6	...	100.00	400	260	8	7	9	385	250	4	3	100
2618-T61	...	100.00	400	310	4	3	5	380	290	4	3	115
3003-H112	...	100.00	95	35	18	16	22	...	...	...	...	25
4032-T6	...	100.00	360	290	3	2	4	...	...	...	...	115
5083-H111	...	100.00	290	150	14	12	12	270	140	12	10	...
5083-H112	...	100.00	275	125	16	14	14	270	110	14	12	...
6061-T6	...	100.00	260	240	7	6	9	260	240	5	4	80
6066-T6	...	100.00	345	310	8	7	10	...	...	...	...	100
6151-T6	...	100.00	305	255	10	9	12	305	255	6	5	90
7049-T73	...	25.00	495	425	7	6	9	490	420	3	2	135
	25.00	50.00	495	425	7	6	9	485	415	3	2	135
	50.00	80.00	490	420	7	6	9	485	415	3	2	135
	80.00	100.00	490	420	7	6	9	485	415	2	1	135
	100.00	130.00	485	415	7	6	9	470	400	2	1	135
7050-T74[H]	...	50.00	495	425	7	6	9	470	385	5	4	135
	50.00	100.00	490	420	7	6	9	460	380	4	3	135
	100.00	130.00	485	415	7	6	9	455	370	3	2	135
	110.00	150.00	485	405	7	6	9	455	370	3	2	135
7075-T6	...	25.00	515	440	7	6	9	490	420	3	2	135
	25.00	50.00	510	435	7	6	...	490	420	3	2	135
	50.00	80.00	510	435	7	6	...	485	415	3	2	135
	80.00	100.00	505	435	7	6	...	485	415	2	1	135
7075-T73	...	80.00	455	385	7	6	...	425	365	3	2	125
	80.00	100.00	440	380	7	6	...	420	360	2	1	125
7075-T7352	...	80.00	455	385	7	6	...	425	350	3	2	125
	80.00	100.00	440	365	7	6	...	420	340	2	1	125
7076-T61	...	100.00	485	415	10	9	10	460	400	3	2	140
7175-T74[H]	...	80.00	525	455	7	6	9	490	425	4	3	...
7175-T7452[H]	...	80.00	505	435	7	6	9	470	380	4	3	...
7175-T7454[H]	...	80.00	515	450	7	6	9	485	420	4	3	...

[A] To determine conformance to this specification, each value for tensile strength and yield strength shall be rounded to the nearest 1 MPa and each value for elongation to the nearest 0.5 % (or the nearest 0.1 % if measured in accordance with 7.6.4 of Test Methods B 557M), in accordance with the rounding-off method of Practice E 29.

[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 50 mm because of the difficulty in obtaining a tension test specimen suitable for routine control testing.

[F] These values apply to standard 12.5-mm diameter test specimens machined from the stock used in making the forgings, or from separately forged coupons representative of the forgings.

[G] A represents cross-sectional area of the specimen.

[H] 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.

4.1.2 Quantity in pieces or kilograms,

4.1.3 Alloy (Section 7),

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,

TABLE 3 Mechanical Property Limits for Rolled Ring Forgings[A,B,C]

Alloy and Temper	Maximum Heat Treat Section Thickness, mm		Direction	Tensile Strength, min, MPa[D]	Yield Strength (0.2 % Offset), min, MPa[D]	Elongation, min,%	
	Over	Through				in 50 mm	in 5× Dia. ($5.65\sqrt{A}$)[E]
2014-T6 and 2014-T652[F]	...	65.00	tangential	450	380	7	6
			axial	425	380	3	2
			radial[G]	415	360	2	1
	65.00	80.00	tangential	450	380	6	5
			axial	425	360	2	1
			radial[G]	...	...	...	...
2219-T6	...	65.00	tangential	385	275	6	5
			axial	380	255	4	3
			radial[G]	365	240	2	1
2618-T61	...	65.00	tangential	380	285	6	5
			axial	380	285	5	4
			radial[G]	...	...	...	...
6061-T6 and 6061-T652[F]	...	65.00	tangential	260	240	10	9
			axial	260	240	8	7
			radial[G]	255	230	5	4
	65.00	90.00	tangential	260	240	8	7
			axial	260	240	6	5
			radial[G]	255	230	4	3
6151-T6 and 6151-T652[F]	...	65.00	tangential	305	255	5	4
			axial	305	240	4	3
			radial[G]	290	240	2	1
7075-T6 and 7075-T652[F]	...	50.00	tangential	505	425	7	6
			axial	495	420	3	2
			radial[G]	470	400	2	1
	50.00	90.00	tangential	490	415	6	5
			axial	485	405	3	2
			radial[G]	...	...	...	...

[A] To determine conformance to this specification each value for tensile strength and yield strength shall be rounded to the nearest 1 MPa and each value for elongation to the nearest 0.5 % (or the nearest 0.1 % if measured in accordance with 7.6.4 of Test Methods B 557M), in accordance with the rounding-off method of Practice E 29.

[B] Tensile property test requirements in any direction are limited to a minimum material dimension of 50.00 mm because of the difficulty in obtaining 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] A represents cross-sectional area of the specimen.

[F] Forgings may be available in the T651 temper but shall be the subject of agreement between the purchaser and producer.

[G] Radial properties are not specified requirements. For wall thicknesses over 50 mm, they will be determined when specifically requested for informational purposes only.

TABLE 4 Ultrasonic Discontinuity Limits for Die and Hand Forgings[A]

Alloy	Product	Thickness, mm		Maximum Mass per Piece, kg	Discontinuity Class[B]
		Over	Through		
2014 2219 7049 7050 7075 7175	die forgings	12.50	100.00	150	B
2014 2219 7049 7050 7075 7175	hand forgings	25.00	200.00	300	A

[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 B 594.

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 (see 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 (see 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 (see 8.3.3),

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

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

4.2.6 Whether heat treatment in accordance with Practice B 918 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 (see 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 B 660 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 his 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 inspections 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 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; for such forgings weighing 2.5 kg or less the maximum mass of a lot shall be 1000 kg; and for heavier forgings it shall be 3000 kg.

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 analyzing samples taken when the ingots are poured, or samples taken from the finished or semifinished product. If the producer has determined the chemical composition during the course of manufacture, he shall not be required to sample and analyze the finished product.

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.

7.2 *Number of Samples*—The number of samples taken for determination of chemical composition shall be as follows:

7.2.1 When samples are taken at the time the ingots are poured, at least one sample shall be taken for each group of ingots poured simultaneously from the same source of molten metal.

7.2.2 When samples are taken from forgings in sizes having a nominal mass of 2.5 kg or less, a sample shall be taken to represent each 1000 kg or fraction thereof of material in the lot.

7.2.3 When samples are taken from forgings in sizes having a nominal mass of more than 2.5 kg, a sample shall be taken to represent each 3000 kg or fraction thereof of material in the lot.

7.3 *Methods of Sampling*—Samples for determination of chemical composition shall be taken in accordance with one of the following methods:

7.3.1 Samples for chemical analysis shall be taken from the material by drilling, sawing, milling, turning, or clipping a representative piece or pieces to obtain a prepared sample not less than 75 g. Sampling shall be in accordance with Practice E 55.

7.3.2 Sampling for spectrochemical analysis shall be in accordance with Practice E 716. Samples for other methods of analysis shall be taken by methods suitable for the form of material being analyzed and the type of analytical method used.

7.4 *Methods of Analysis*—The determination of chemical composition shall be made in accordance with suitable chemical (Test Methods E 34) or spectrochemical (Test Methods E 607 and E 1251) methods. Other methods may be used only when no published ASTM test method is available. In case of dispute the methods of analysis shall be agreed upon between the producer and purchaser.

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 Methods B 557M.

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 7.6.4 of Test Methods B 557M.

8.4.3 Brinell hardness tests shall be made in accordance with Test Method E 10, 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.

9. Heat Treatment

9.1 Unless otherwise specified, 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 B 918.

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 F and 01 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 F and 01 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.

10.3 Alloys 7049, 7050, and 7175 die and hand forgings in the F and O tempers and, when specified, 7075 die and hand forgings in the F and 01 tempers (within the size limits specified in Table 2 and Table 5, respectively) shall, after proper solution heat treatment and precipitation heat treatment, conform to the tensile properties specified in Table 2 and Table 5, as applicable for T73 type temper, and Section 12.

10.4 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.

10.5 *Number of Specimens*—One specimen from each lot of F and 01 temper die forgings, hand forgings, and rolled ring forgings shall be tested to verify conformance with 10.1-10.4 as applicable.

11. Heat-Treatment and Reheat-Treatment Capability

11.1 As-received die and hand forgings in the F and 01 temper in alloys 2014, 2018, 2025, 2218, 2219, 2618, 4032,

6061, 6066, 6151, 7075, and 7076 (within the size limitations specified in Table 2 and Table 5) shall, after proper solution heat treatment and precipitation heat treatment, be capable of conforming to the tensile properties specified in Table 2 and Table 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 Table 2 and Table 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 ranges 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.

TABLE 5 Mechanical Property Limits for Hand Forging[A,B]

Alloy and Temper	Thickness[C], mm		Direction	Tensile Strength, min, MPa	Yield Strength (0.2% Offset), min, MPa	Elongation in 5× Diameter ($5.65\sqrt{A}$)[D]
	Over	Through				
2014-T6	...	50.00	longitudinal	450	385	7
			long transverse	450	385	2
	50.00	80.00	longitudinal	440	385	7
			long transverse	440	380	2
			short transverse	425	380	1
	80.00	100.00	longitudinal	435	380	7
			long transverse	435	380	2
			short transverse	420	370	1
	100.00	130.00	longitudinal	425	370	6
			long transverse	425	370	1
			short transverse	415	365	...
	130.00	150.00	longitudinal	420	365	6
			long transverse	420	365	1
			short transverse	405	365	...
	150.00	180.00	longitudinal	415	360	5
			long transverse	415	360	1
			short transverse	400	360	...
	180.00	200.00	longitudinal	405	350	5
			long transverse	405	350	1
			short transverse	395	350	...
2014-T652	...	50.00	longitudinal	450	385	7
			long transverse	450	385	2
	50.00	80.00	longitudinal	440	385	7
			long transverse	440	380	2
			short transverse	425	360	1
	80.00	100.00	longitudinal	435	380	7
			long transverse	435	380	2
			short transverse	420	350	1
	100.00	130.00	longitudinal	425	370	6
			long transverse	425	370	1
			short transverse	415	345	...
	130.00	150.00	longitudinal	420	365	6
			long transverse	420	365	1
			short transverse	405	345	...
	150.00	180.00	longitudinal	415	360	5
			long transverse	415	360	1
			short transverse	400	340	...
	180.00	200.00	longitudinal	405	350	5
			long transverse	405	350	1
			short transverse	395	330	...
2219-T6	...	100.00	longitudinal	400	275	5
			long transverse	380	255	3
			short transverse[E]	365	240	1
2219-T852	...	100.00	longitudinal	425	345	5
			long transverse	425	340	3
			short transverse[E]	415	315	2
2618-T61	...	50.00	longitudinal	400	325	6
			long transverse	380	290	4
			short transverse[E]	360	290	3
	50.00	80.00	longitudinal	395	315	6
			long transverse	380	290	4
			short transverse	360	290	3
	80.00	100.00	longitudinal	385	310	6
			long transverse	365	275	4
			short transverse	350	270	3
			long transverse	270	110	12

TABLE 5 *Continued*

Alloy and Temper	Thickness[C], mm		Direction	Tensile Strength, min, MPa	Yield Strength (0.2% Offset), min, MPa	Elongation in 5× Diameter ($5.65\sqrt{A}$)[D]
	Over	Through				
5083-H111	...	100.00	longitudinal	290	150	12
			long transverse	270	140	10
5083-H112	...	100.00	longitudinal	275	125	14
			long transverse	270	110	12
6061-T6 or T652	...	100.00	longitudinal	260	240	9
			long transverse	260	240	7
			short transverse[E]	255	230	4
	100.00	200.00	longitudinal	255	235	7
			long transverse	255	235	5
			short transverse	240	220	3
7049-T73	50.00	80.00	longitudinal	490	420	8
			long transverse	490	405	3
			short transverse	475	400	2
	80.00	100.00	longitudinal	475	405	7
			long transverse	475	395	2
			short transverse	460	385	1
	100.00	130.00	longitudinal	460	385	6
			long transverse	460	385	2
			short transverse	455	380	1
7049-T7352	25.00	80.00	longitudinal	490	405	8
			long transverse	490	395	3
			short transverse[E]	475	385	2
	80.00	100.00	longitudinal	475	395	7
			long transverse	475	370	2
			short transverse	460	365	1
	100.00	130.00	longitudinal	460	370	6
			long transverse	460	365	2
			short transverse	455	350	1
7050-T7452[F]	...	50.00	longitudinal	495	435	8
			long transverse	490	420	4
	50.00	80.00	longitudinal	495	425	8
			long transverse	485	415	4
			short transverse	460	380	3
	80.00	100.00	longitudinal	490	420	8
			long transverse	485	405	4
			short transverse	460	380	3
	100.00	130.00	longitudinal	485	415	8
			long transverse	475	400	3
			short transverse	455	370	2
	130.00	150.00	longitudinal	475	405	8
			long transverse	470	385	4
			short transverse	455	365	2
	150.00	180.00	longitudinal	470	400	8
			long transverse	460	370	3
			short transverse	450	350	2
	180.00	200.00	longitudinal	460	395	8
			long transverse	455	360	3
			short transverse	440	345	2
7075-T6	...	50.00	longitudinal	510	435	8
			long transverse	505	420	3
	50.00	80.00	longitudinal	505	420	8
			long transverse	490	405	3
			short transverse	475	400	2
	80.00	100.00	longitudinal	490	415	7
			long transverse	485	400	2
			short transverse	470	395	1
	100.00	130.00	longitudinal	475	400	6
			long transverse	470	385	2
			short transverse	455	385	1
	130.00	150.00	longitudinal	470	385	5
			long transverse	455	380	2
			short transverse	450	380	1
7075-T652	...	50.00	longitudinal	510	435	8
			long transverse	505	420	3
	50.00	80.00	longitudinal	505	420	8
			long transverse	490	405	3
			short transverse	475	395	1
	80.00	100.00	longitudinal	490	415	7
			long transverse	485	400	2
			short transverse	470	385	...
	100.00	130.00	longitudinal	475	400	6
			long transverse	470	385	2

TABLE 5 *Continued*

Alloy and Temper	Thickness[C], mm		Direction	Tensile Strength, min, MPa	Yield Strength (0.2% Offset), min, MPa	Elongation in 5× Diameter ($5.65\sqrt{A}$)[D]
	Over	Through				
			short transverse	455	380	...
	130.00	150.00	longitudinal	470	385	5
			long transverse	455	380	2
			short transverse	450	370	...
7075-T73	...	80.00	longitudinal	455	385	6
			long transverse	440	370	3
			short transverse[E]	420	360	2
	80.00	100.00	longitudinal	440	380	6
			long transverse	435	365	2
			short transverse	415	350	1
	100.00	130.00	longitudinal	425	365	6
			long transverse	420	350	2
			short transverse	400	345	1
	130.00	150.00	longitudinal	420	350	5
			long transverse	405	345	2
			short transverse	395	340	1
7075-T7352	...	80.00	longitudinal	455	370	6
			long transverse	440	360	3
			short transverse[E]	420	345	2
	80.00	100.00	longitudinal	440	365	6
			long transverse	435	345	2
			short transverse	415	330	1
	100.00	130.00	longitudinal	425	350	6
			long transverse	420	330	2
			short transverse	400	315	1
	130.00	150.00	longitudinal	420	340	5
			long transverse	405	315	2
			short transverse	395	305	1
7175-T74[F]	...	80.00	longitudinal	505	435	8
			long transverse	490	415	4
			short transverse[E]	475	415	3
	80.00	100.00	longitudinal	490	420	8
			long transverse	485	400	4
			short transverse	470	395	3
	100.00	130.00	longitudinal	470	395	7
			long transverse	460	385	4
			short transverse	455	380	3
	130.00	150.00	longitudinal	450	370	7
			long transverse	440	360	4
			short transverse	435	360	3
7175-T7452[F]	...	80.00	longitudinal	490	420	8
			long transverse	475	400	4
			short transverse[E]	460	370	3
	80.00	100.00	longitudinal	470	395	8
			long transverse	460	380	4
			short transverse	450	350	3
	100.00	130.00	longitudinal	450	370	7
			long transverse	440	360	4
			short transverse	435	340	3
	130.00	150.00	longitudinal	435	350	7
			long transverse	420	340	4
			short transverse	415	315	1

[A] To determine conformance to this specification, each value for tensile strength and yield strength shall be rounded to the nearest 1 MPa and each value for elongation to the nearest 0.5 % (or the nearest 0.1 % if measured in accordance with 7.6.4 of Test Methods B 557M), in accordance with the rounding-off method of Practice E 29.

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

[C] Maximum cross-sectional area is 165 000 mm^2, except that for 2618-T61 it is 93 000 mm^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] *A* represents cross-sectional area of the specimen.

[E] Tensile property test requirements in any direction are limited to a minimum material dimension of 50.00 mm because of the difficulty in obtaining a tension test specimen suitable for routine control testing.

[F] 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.

12. Stress-Corrosion Resistance

12.1 Alloys 7049 and 7075 in the T73-type tempers and 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 on each of the applicable alloy-tempers for each thickness range 20.00 mm 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 20.00 mm 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 T74-type tempers: 240 MPa for die and hand forgings up through 75.00 mm and 50 % of the minimum longitudinal yield strength specified in Table 5 for hand forgings over 75.00 mm.

12.2.2 The test corrosion test shall be made in accordance with Test Method G 47.

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 150 kg, in thicknesses over 12.50 mm through 100.00 mm, in alloys 2014, 2219, 7049, 7050, 7075, and 7175, and each hand forging not more than 300 kg, in thicknesses over 25.00 mm through 200.00 mm in alloys 2014, 2219, 7049, 7050, 7075, and 7175, shall be tested ultrasonically in accordance with Practice B 594 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 B 594 shall be the subject of agreement between the purchaser and the 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 the subject of 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.

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 exceeds the minimum by less than 70 MPa	acceptable
	38.0 through 39.9	per specified requirement but longitudinal yield strength exceeds the minimum by 70 MPa 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 220 or less	acceptable
	38.0 or greater	per specified requirements but SCF[E] is over 220	unacceptable[B]
	less than 38.0	any level	unacceptable[B]
7075-T73 and T7352 and 7175-T74[C], T7452[E] and T7454[E]	40.0 or greater	per specified requirements	acceptable
	38.0 through 39.9	per specified requirements and longitudinal yield strength exceeds the minimum by less than 85 MPa	acceptable
	38.0 through 39.9	per specified requirements but longitudinal yield strength exceeds the minimum by 85 MPa 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 E 1004.

[B] Alloy 7049 material in Tempers T73 and T7352, and Alloy 7050 material in Tempers T74 and T7452, when unacceptable in accordance with the lot acceptance criteria, shall be subject to reprocessing by additional 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] Die forgings in the T74 temper also are restricted to having yield strength, parallel to the direction of grain flow, not to exceed 495 MPa.

[E] Stress-Corrosion Susceptibility Factor (SCF) equals yield strength (XXX MPa) − 7 × electrical conductivity (XX.X % IACS).

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 sulfide dissolved in 1 L of water. Etching time for this solution when maintained at 66 to 71°C 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-sulfuric acid solution or any other equivalent solution to produce a surface suitable for visual or penetrant inspection.

15.3 Unless otherwise specified, each 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 Practice E 165, 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 6mm. 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 mass 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 masses, 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 B 660. 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 Limits are established at a level at which a statistical evaluation of the data indicates that 99 % of the population obtained from all standard material meets the limit with 95 % confidence. For the products described, mechanical property limits for the respective size ranges are based on the analyses of at least 100 data from standard production material with no more than ten data from a given lot. All tests are performed in accordance with the appropriate ASTM test methods. For informational purposes, refer to "Statistical Aspects of Mechanical Property Assurance" in the Related Material section of the *Annual Book of ASTM Standards*, Vol 02.02. Mechanical property limits in this metric issue were derived from the inch-pound system limits that were developed under the above principles. As test data on metric dimensioned specimens are accumulated, some refinement of limits, particularly for elongations measured in 5D, can be anticipated.

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(M). The Aluminum Association[13] 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 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(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 (Note A2.1); Titanium; 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 zinc and titanium, or are specified in footnotes.

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

[13] The Aluminum Association, 900 19th St., NW, Washington, DC 20006.

APPENDIX

(Nonmandatory Information)

X1. INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) EQUIVALENTS OF ANSI ALLOYS AND TEMPERS

X1.1 International Organization for Standardization (ISO) equivalents of the ANSI alloys and tempers given in Table X1.1 and Table X1.2 are included in ISO 209-1: 1989, Part 1, Chemical Composition and ISO 2107: 1983.

TABLE X1.1 ISO Equivalents of Alloys in B 247M

Alloys			
ANSI	ISO	ANSI	ISO
1100	Al 99.0 Cu	5083	Al Mg4.5Mn0.7
2014	Al Cu4SiMg	6061	Al Mg1SiCu
3003	Al Mn1Cu	7050	Al Zn6CuMgZr
4043	Al Si5	7075	Zn5.5MgCu

TABLE X1.2 ISO Equivalents of Tempers in B 247M

Tempers	
ANSI	ISO
O	O
H112	M
T4	TB
T6	TF
T7	TM

SUMMARY OF CHANGES

Committee B07 has identified the location of selected changes to this standard since the last issue (B 247M – 02) that may impact the use of this standard.

(1) Updated Footnote 1.