



# Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings<sup>1</sup>

This standard is issued under the fixed designation B 247; 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 ( $\epsilon$ ) 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<sup>2</sup> 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 B 211. For forging stock supplied as extruded bar or rod see Specification B 221.

1.2 Alloy and temper designations are in accordance with ANSI H35.1. 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 A complete metric standard to Specification B 247 has been developed—Specification B 247M; therefore, no metric equivalents are presented 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<sup>3</sup>

B 221 Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wires, Profiles, and Tubes<sup>3</sup>

B 557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products<sup>3</sup>

B 594 Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications<sup>3</sup>

B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products<sup>3</sup>

B 881 Terminology Relating to Aluminum- and Magnesium-Alloy Products<sup>3</sup>

B 918 Practice for Heat Treatment of Wrought Aluminum Alloys<sup>3</sup>

E 10 Test Method for Brinell Hardness of Metallic Materials<sup>4</sup>

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>5</sup>

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum Base Alloys<sup>6</sup>

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition<sup>6</sup>

E 165 Test Method for Liquid Penetrant Examination<sup>7</sup>

E 527 Practice for Numbering Metals and Alloys (UNS)<sup>8</sup>

E 607 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere<sup>6</sup>

E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis<sup>6</sup>

E 1004 Practice for Determining Electrical Conductivity Using the Electromagnetic Eddy-Current Method<sup>7</sup>

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<sup>6</sup>

G 47 Test Method for Determining Susceptibility to Stress-Corrosion Cracking of 2XXX and 7XXX Aluminum-Alloy Products<sup>9</sup>

### 2.3 ANSI Standard:

H35.1 Alloy and Temper Designation Systems for Aluminum<sup>3</sup>

<sup>1</sup> 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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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SB-247 in Section II of that Code.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 02.02.

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

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 03.05.

<sup>7</sup> *Annual Book of ASTM Standards*, Vol 03.03.

<sup>8</sup> *Annual Book of ASTM Standards*, Vol 01.01.

<sup>9</sup> *Annual Book of ASTM Standards*, Vol 03.02.

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

**TABLE 1 Chemical Composition Limits<sup>A,B,C</sup>**

Alloy	Silicon	Iron	Copper	Man-ganese	Mag-nesium	Chro-mium	Nickel	Zinc	Zir-conium	Titanium	Other Elements <sup>D</sup>		Alumi-num
											Each	Total <sup>E</sup>	
1100	0.95 Si + Fe		0.05–0.20	0.05	...	...	...	0.10	...	...	0.05	0.15	99.00 min <sup>F</sup>
2014	0.50–1.2	0.7	3.9–5.0	0.40–1.2	0.40–0.8	0.10	...	0.25	...	0.15 <sup>G</sup>	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 <sup>H</sup>	0.15 <sup>H</sup>	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 <sup>I</sup>	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

<sup>A</sup> Limits are in weight percent maximum unless shown as a range or stated otherwise.

<sup>B</sup> Analysis shall be made for the elements for which limits are shown in this table.

<sup>C</sup> 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.

<sup>D</sup> *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.

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

<sup>F</sup> 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.

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

<sup>H</sup> Vanadium, 0.05–0.15 %.

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

## 2.4 Military Standards:

MIL-STD-129 Marking for Shipment and Storage<sup>10</sup> (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 Materials<sup>11</sup>

## 2.6 Federal Standard:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)<sup>10</sup>

## 2.7 National Aerospace Standard:

NAS 410 Certification and Qualification of Nondestructive Test Personnel<sup>12</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 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),

4.1.2 Quantity in pieces or pounds,

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,

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 B 918 is required (9.2),

<sup>10</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

<sup>11</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

<sup>12</sup> Available from Aerospace Industries Association (AIA), 1250 Eye St., NW, Washington, DC 20005.

**TABLE 2 Mechanical Property Limits for Die Forgings<sup>A,B</sup>**

Alloy and Temper	Specified Thickness, in.	Specimen Axis Parallel to Direction of Grain Flow <sup>C</sup>				Specimen Axis Not Parallel to Direction of Grain Flow <sup>C</sup>			
		Tensile Strength <sup>E</sup> , min, ksi	Yield Strength <sup>E</sup> (0.2 % Offset), min, ksi	Elongation <sup>E</sup> in 2 in. or 4 × Dia, min, %		Tensile Strength <sup>E</sup> , min, ksi	Yield Strength <sup>E</sup> (0.2 % Offset), min, ksi	Elongation <sup>E</sup> in 2 in. or 4 × Dia., min, % Forgings	Brinell Hardness <sup>D</sup> , min
				Forgings	Separate Test Coupon (from stock or forged) <sup>F</sup>				
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 <sup>G</sup>	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 <sup>G</sup>	up through 3.000	76.0	66.0	7	10	71.0	62.0	4	...
7175-T7452 <sup>G</sup>	up through 3.000	73.0	63.0	7	10	68.0	55.0	4	...
7175-T7454 <sup>G</sup>	up through 3.000	75.0	65.0	7	10	70.0	61.0	4	...

<sup>A</sup> 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 7.6.4 of Test Methods B 557), in accordance with the rounding-off method of Practice E 29.

<sup>B</sup> For the basis for establishment of strength property limits, see Annex A1.

<sup>C</sup> 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.

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

<sup>E</sup> 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.

<sup>F</sup> These values apply to standard 1/2-in. diameter test specimens machined from the stock used in making the forgings, or from separately forged coupons representative of the forgings.

<sup>G</sup> 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.

4.2.7 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),