Designation: B316/B316M – 15

Standard Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods[1]

This standard is issued under the fixed designation B316/B316M; 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 specification covers wire and rod in the alloys (Note 1) shown in Table 1 and the tempers shown in Table 2 [Table 3] and Table 4 [Table 5], suitable for manufacturing rivets and other similar items by cold-heading operations.

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

NOTE 2—For rolled or cold-finished wire and rod, see Specification B211, and for extruded wire and rod, see Specification B221.

1.2 Alloy and temper designations are in accordance with ANSI H35.1/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 E527.

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

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4.1 The SI units are shown either in brackets or in separate tables.

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:*[2]

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

B557M Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)

B565 Test Method for Shear Testing of Aluminum and Aluminum-Alloy Rivets and Cold-Heading Wire and Rods

B660 Practices for Packaging/Packing of Aluminum and Magnesium Products

B666/B666M Practice for Identification Marking of Aluminum and Magnesium 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

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

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)[3]

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

[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 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.

[3] 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**

2.3 *ANSI Standards:*[4]
H35.1/H35.1M Alloy and Temper Designation Systems for Aluminum
H35.2 Dimensional Tolerances for Aluminum Mill Products
H35.2M Dimensional Tolerances for Aluminum Mill Products [Metric]
2.4 *Military Standard:*
MIL-STD-129 Marking for Shipment and Storage[5]
2.5 *AMS Specification:*
AMS 2772 Heat Treatment of Aluminum Alloy Raw Materials[6]
2.6 *Federal Standard:*
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[5]
2.7 *CEN EN Standards:*[7]
EN 14242 Aluminum and Aluminum Alloys. Chemical Analysis Inductively Coupled Plasma Optical Emission Spectral Analysis

3. Terminology

3.1 *Definitions:*
3.1.1 *rod, n*—a solid product 0.375 in. or greater [over 10 mm] in diameter, that is long in relation to cross section.

3.1.2 *cold-heading rod, n*—rod of a quality suitable for use in the manufacture of cold-headed products such as rivets and bolts.

3.1.3 *rivet rod, n*—see *cold-heading rod.*
3.1.4 *wire, n*—a solid wrought product that is long in relation to its cross section, which is square or rectangular with sharp or rounded corners or edges, or is round, a regular hexagon, or a regular octagon, and whose diameter or greatest perpendicular distances between parallel faces (except for flattened wire) is less than 0.375 in. [up through 10 mm]

3.1.5 *cold-heading wire, n*—wire of a quality suitable for use in the manufacture of cold-headed products such as rivets and bolts.

3.1.6 *rivet wire, n*—see *cold-heading wire.*

4. Ordering Information

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

NOTE 3—For inch-pound orders specify Specification B316; for metric orders specify Specification B316M. Do not mix units.

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 [kilograms],
4.1.3 Alloy (see 7.1),
4.1.4 Temper (see 8.1),
4.1.5 Diameter,
4.1.6 Form-coiled or straight lengths,

4.2 Additionally, orders for material to this specification shall include the following information when required by the purchaser:
4.2.1 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 13),
4.2.2 Whether certification is required (Section 15),
4.2.3 Whether marking for identification is required (Section 16), and
4.2.4 Whether Practices B660 applies and, if so, the levels of preservation, packaging, and packing required (17.3).

5. Materials and Manufacture

5.1 The products covered by this specification shall be produced by extruding, rolling, or drawing, or a combination thereof, 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 assure 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 an identifiable quantity of material of the same mill form, alloy, temper, and nominal diameter traceable to a heat-treat lot or lots, and subjected to inspection at one time.
6.2.2 For nonheat-treated tempers, an inspection lot shall consist of an identifiable quantity of material of the same mill form, alloy, temper, and nominal diameter subjected to inspection at one time.

7. Chemical Composition

7.1 *Limits*—The material shall conform to the chemical composition limits specified in Table 1. Conformance shall be determined by the producer by taking samples in accordance with Practices E716 when the ingots are poured, and analyzing those samples in accordance with Test Methods E34, E607, E1251, 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 Alloy Rivet and Cold-Heading Wire and Rods 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 Practice B985.

[4] Available from Aluminum Association, Inc., 1400 Crystal Drive, Suite 430 Arlington, VA 22202 (http://www.aluminum.org).
[5] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.
[6] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.
[7] Available from European Committee for Standardization, Central Secretariat, (CEN), Rue de Stassart 36, B1050 Brussels, Belgium, http//www.cen.eu/esearch.

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

Alloy	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Zinc	Titanium	Other Elements[D]		Aluminum
									Each	Total[E]	
1100	0.95 Si + Fe		0.05–0.20	0.05	...	...	0.10	...	0.05	0.15	99.00 min[F]
2017	0.20–0.8	0.7	3.5–4.5	0.40–1.0	0.40–0.8	0.10	0.25	0.15	0.05	0.15	remainder
2024	0.50	0.50	3.8–4.9	0.30–0.9	1.2–1.8	0.10	0.25	0.15	0.05	0.15	remainder
2117	0.8	0.7	2.2–3.0	0.20	0.20–0.50	0.10	0.25	...	0.05	0.15	remainder
2219	0.20	0.30	5.8–6.8	0.20–0.40	0.02	...	0.10	0.02–0.10	0.05[G]	0.15[G]	remainder
3003	0.6	0.7	0.05–0.20	1.0–1.5	...	...	0.10	...	0.05	0.15	remainder
5005	0.30	0.7	0.20	0.20	0.50–1.1	0.10	0.25	...	0.05	0.15	remainder
5052	0.25	0.40	0.10	0.10	2.2–2.8	0.15–0.35	0.10	...	0.05	0.15	remainder
5056	0.30	0.40	0.10	0.05–0.20	4.5–5.6	0.05–0.20	0.10	...	0.05	0.15	remainder
6053	[H]	0.35	0.10	...	1.1–1.4	0.15–0.35	0.10	...	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
7050	0.12	0.15	2.0–2.6	0.10	1.9–2.6	0.04	5.7–6.7	0.06	0.05[I]	0.15[I]	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	0.05	0.15	remainder

[A] Limits are in weight [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] To determine conformance to these limits, an observed value or a calculated value obtained from analysis shall be rounded off 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 this 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 the metallic elements present in amounts of 0.010 % or more each, rounded to the second decimal before determining the sum.
[G] Vanadium, 0.05–0.15 %; zirconium, 0.10–0.25 %. The total for other elements does not include vanadium and zirconium.
[H] 45 to 65 % of actual magnesium content.
[I] Zirconium 0.08–0.15 %. The total for other elements does not include zirconium.
[J] In case of 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" should be considered the controlling composition. The "Teal Sheets" are available at http://www.aluminum.org/tealsheets.

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

7.3 Other methods of analysis or in the case of dispute may be by agreement between the producer and the purchaser.

NOTE 4—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.

NOTE 5—It is difficult to obtain a reliable analysis of each of the components of clad materials using material in its finished state. A reasonably accurate determination of the core composition can be made if the cladding is substantially removed prior to analysis. The cladding composition is more difficult to determine because of the relatively thin layer and because of diffusion of core elements to the cladding. The correctness of cladding alloy used can usually be verified by a combination of metallographic examination and spectrochemical analysis of the surface at several widely separated points.

8. Mechanical Properties

8.1 *Tensile Properties of Material as Supplied*—The material shall conform to the tensile strength requirements specified in Table 2 [Table 3].

8.2 *Mechanical Properties of Material after Heat Treatment*—In addition to the requirements of 8.1, heat-treatable material ordered in the annealed or strain-hardened tempers and subsequently solution heat treated (T4) or solution and precipitation heat treated (T6, T61, T62, T7, or T73), shall conform to the requirements of Table 4 [Table 5] for either tensile strength or shear strength, at the producer's option. However, the material shall be capable of meeting both the tensile and shear strength requirements.

8.3 *Number of Specimens:*

8.3.1 One tension test specimen shall be taken for each 1000 lb or fraction thereof in the lot to determine compliance with 8.1. Only one specimen shall be taken from any one piece.

8.3.2 The number of tests to determine compliance with 8.2 shall be the same as in 8.3.1.

8.4 *Test Methods:*

8.4.1 The tension tests shall be made in accordance with Test Methods B557 [B557M].

8.4.2 The shear tests shall be made in accordance with Test Method B565.

9. Heat Treatment

9.1 Unless specified in 9.2, producer or supplier heat treatment for the applicable tempers in Table 4 shall be in accordance with AMS 2772.

9.2 When specified, heat treatment for the applicable tempers in Table 4 shall be in accordance with Practice B918.

10. Stress-Corrosion Resistance

10.1 For lot acceptance purposes, resistance to stress-corrosion cracking for each lot of 7050-T7 and 7075-T73 material shall be established by testing the previously selected tension-test samples to the criteria shown in Table 6.

TABLE 2 Tensile Property Limits (Inch-Pound Units)[A,B]

Alloy	Temper	Diameter, in.	Tensile Strength, ksi	
			min	max
1100	O	up through 1.000	...	15.5
	H14	up through 1.000	16.0	21.0
2017	O	up through 1.000	...	35.0
	H13	up through 1.000	30.0	40.0
2024	O	up through 1.000	...	35.0
	H13	up through 1.000	32.0	42.0
2117	O	up through 1.000	...	25.0
	H15	up through 1.000	28.0	35.0
	H13	up through 1.000	25.0	32.0
2219	0	up through 1.000	...	32.0
	H13	up through 1.000	28.0	38.0
3003	O	up through 1.000	...	19.0
	H14	up through 1.000	20.0	26.0
5005	O	up through 1.000	...	20.0
	H32	up through 1.000	17.0	23.0
5052	O	up through 1.000	...	32.0
	H32	up through 1.000	31.0	37.0
5056	O	up through 1.000	...	46.0
	H32	up through 1.000	44.0	52.0
6053	O	up through 1.000	...	19.0
	H13	up through 1.000	19.0	26.0
6061	O	up through 1.000	...	22.0
	H13	up through 1.000	22.0	30.0
7050	O	up through 1.000	...	40.0
	H13	up through 1.000	34.0	44.0
7075	O	up through 1.000	...	40.0
	H13	up through 1.000	36.0	46.0

[A] To determine conformance to this specification, each value for tensile strength shall be rounded to the nearest 0.1 ksi in accordance with the rounding-off method of Practice E29.
[B] See Annex A1 for basis of mechanical property limits.

TABLE 3 Tensile Property Limits [SI Units][A,B]

Alloy	Temper	Specified Diameter, mm		Tensile Strength, MPa	
		over	Up through	min	max
1100	O	...	25.00	...	110
	H14	...	25.00	110	145
2017	O	...	25.00	...	240
	H13	...	25.00	205	275
2024	O	...	25.00	...	240
	H13	...	25.00	220	290
2117	O	...	25.00	...	175
	H15	...	25.00	190	240
	H13	...	25.00	170	220
2219	0	...	25.00	...	220
	H13		25.00	190	260
3003	O	...	25.00	...	130
	H14	...	25.00	135	180
5005	O	...	25.00	...	140
	H32	...	25.00	115	160
5052	O	...	25.00	...	220
	H32	...	25.00	215	255
5056	O	...	25.00	...	320
	H32	...	25.00	300	360
6053	O	...	25.00	...	130
	H13	...	25.00	130	180
6061	O	...	25.00	...	155
	H13	...	25.00	150	210
7050	O	...	25.00	...	275
	H13	...	25.00	235	305
7075	O	...	25.00	...	275
	H13	...	25.00	245	320

[A] To determine conformance to this specification, each value for tensile strength shall be rounded off to the nearest 1 MPa in accordance with the rounding-off method of Practice E29.
[B] The basis for establishment of mechanical property limits is shown in Annex A1.

TABLE 4 Mechanical Property Limits of Heat-Treatable Alloys (After Heat Treatment) (Inch-Pound Units)[A,B]

Alloy	Temper	Diameter, in.	Tensile Strength min, ksi	Yield Strength[C] (0.2 % offset) min, ksi	Elongation[C] in 2 in., or 4 × Diameter min,%	Shear Strength min, ksi
2017	T4	0.063–1.000	55.0	32.0	12	33.0
2024	T42	0.063–0.124	62.0	...	...	37.0
		0.125–1.000	62.0	40.0	10	37.0
2117	T4	0.063–1.000	38.0	18.0	18	26.0
2219	T6	0.063–1.000	55.0	35.0	6	30.0
6053	T61	0.063–1.000	30.0	20.0	14	20.0
6061	T6	0.063–1.000	42.0	35.0	10	25.0
7050	T7	0.063–1.000	70.0	58.0	10	39.0
7075	T6	0.063–1.000	77.0	66.0	7	42.0
7075	T73	0.063–1.000	68.0	56.0	10	41.0

[A] To determine conformance to this specification, each value for tensile strength, yield strength, and shear strength shall be rounded off to the nearest 0.1 ksi, and each value for elongation shall be rounded to the nearest 0.5 %, both in accordance with the rounding-off method of Practice E29.
[B] See Annex A1 for basis of mechanical property limits.
[C] The measurement of elongation and yield strength is not required for wire less than 0.125 in. in diameter.

TABLE 5 Mechanical Property Limits of Heat Treatable Alloys (After Heat Treatment) [SI Units][A,B]

Alloy	Temper	Specified Diameter, mm		Tensile Strength min, MPa	Yield Strength[C] 0.2 % offset min, MPa	Elongation[C], min, % in 5 × Diameter $5.65\sqrt{A^D}$	Shear Strength min, MPa
		over	through				
2017	T4	1.60	25.00	380	220	10	225
2024	T42	1.60	3.20	425	...	...	255
		3.20	25.00	425	275	9	255
2117	T4	1.60	25.00	260	125	16	180
2219	T6	1.60	25.00	380	240	5	205
6053	T61	1.60	25.00	205	135	12	135
6061	T6	1.60	25.00	290	240	9	170
7050	T7	1.60	25.00	485	400	9	270
7075	T6	1.60	25.00	530	455	6	290
7075	T73	1.60	25.00	470	385	9	280

[A] To determine conformance to this specification, each value for tensile strength, yield strength, and shear strength shall be rounded off to the nearest 1 MPa and each value for elongation shall be rounded to the nearest 0.5 %, both in accordance with the rounding-off method of Practice E29.
[B] The basis for establishment of mechanical property limits is shown in Annex A1.
[C] The measurement of elongation and yield strength is not required for wire 3.20 mm and less in diameter.
[D] *A* is the cross-sectional area of the specimen.

TABLE 6 Lot Acceptance Criteria for Resistance to Stress -Corrosion- Lot Acceptance Criteria

Alloy and Temper	Electrical Conductivity[A] %IACS	Level of Mechanical Properties	Lot Acceptance Status
7050-T7	41.0 and greater	per specified requirements	acceptable
	40.0 through 40.9	per specified requirements and longitudinal yield strength does not exceed 69.0 ksi [475 MPa]	
	40.0 through 40.9	per specified requirements but longitudinal yield strength exceeds 69.0 ksi	unacceptable[B]
	Less than 40.0	any level	
7075-T73	40.0 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 [82 MPa]	
	38.0 through 39.9	per specified requirements but longitudinal yield strength exceeds minimum by 12 ksi or more [more than 82 MPa]	unacceptable[B]
	Less than 38.0	any level	

[A] The electrical conductivity shall be determined on the surface of the tensile-test sample in accordance with Practice E1004.
[B] When material is found to be unacceptable, it shall be reprocessed (additional precipitation heat treatment or re-solution heat treatment and precipitation heat treatment).

10.2 The producer shall maintain records of all lots so tested and make them available for examination at the producer's facility.

11. Dimensional Tolerances

11.1 Variations from the specified diameter, length, and straightness shall not exceed the permissible variations prescribed in Tables 10.5, 10.13, and 10.15 of ANSI H35.2 [H35.2M].

12. General Quality

12.1 Unless otherwise specified, the material shall be supplied in the mill finish and shall be uniform as defined by the requirements of this specification and shall be commercially sound. Any requirement not so covered is subject to negotiation between producer and purchaser.

13. Source Inspection

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

13.2 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 material meets the requirements of this specification. Inspection and tests shall be conducted so there is not unnecessary interference with the producer's operations.

14. Retest and Rejection

14.1 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.

14.2 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 re-test shall meet the requirements of the specification or the lot shall be subject to rejection.

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

14.4 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.

15. Certification

15.1 The producer or supplier shall, on request, furnish to the purchaser a certificate stating that each lot has been sampled, tested, and inspected in accordance with this specification, and has been found to meet the requirements.

16. Identification Marking of Product

16.1 When specified in the contract or purchase order all material shall be marked in accordance with Practice B666/B666M.

16.2 The requirements specified in 16.1 are minimum; marking systems that involve added information, larger characters, and greater frequencies are acceptable under this specification.

17. Packaging and Package Marking

17.1 The material 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. The type of packing and gross weight of container shall, unless otherwise agreed upon, be at the producer's discretion, provided that they are such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the delivery point.

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

17.3 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.

18. Keywords

18.1 aluminum alloy; aluminum-alloy rivet; cold-heading rods; cold-heading wire

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 publications "Tempers for Aluminum and Aluminum Alloy Products (Yellow and Tan Sheets)."

A1.1.1 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 five cast lots of standard production material with no more than ten 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".

A1.1.2 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.

A1.1.3 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/H35.1M. The Aluminum Association[4] 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/H35.1M. 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 this 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 (B316/B316M – 10) that may impact the use of this standard. (Approved Oct. 1, 2015.)

(1) Revised Table 6 for clarity.
(2) Added Practice B985 to 2.2 and 7.2.
(3) Revised Table 2.
(4) Removed alloy 7178 from Tables 1-5.
(5) Removed Note 1 from Table 1, placed content in new Footnote J.