Designation: B 209 – 01

Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate[1]

This standard is issued under the fixed designation B 209; 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[2] covers aluminum and aluminum-alloy flat sheet, coiled sheet, and plate, in the alloys (Note 1) and tempers shown in Tables 2 and 3, and in the following finishes:

1.1.1 Plate in all alloys and sheet in heat-treatable alloys: mill finish.

1.1.2 Sheet in nonheat-treatable alloys: mill finish, one-side bright mill finish, standard one-side bright finish, and standard two-sides bright finish.

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

NOTE 2—See Specification B 632 for tread plate.

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 527E 527.

1.3 A complete metric companion to Specification B 209 has been developed—B 209M; therefore, no metric equivalents are presented in this specification.

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

2. Referenced Documents

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

2.2 *ASTM Standards:*

B 548 Method for Ultrasonic Inspection of Aluminum-Alloy Plate for Pressure Vessels[3]

B 557 Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products[3]

B 594 Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications[3]

B 597 Practice for Heat Treatment of Aluminum Alloys[3]

B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products[3]

B 666/B 666M Practice for Identification Marking of Aluminum and Magnesium Products[3]

E 3 Methods of Preparation of Metallographic Specimens[4]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[5]

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys[6]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[6]

E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique[6]

E 290 Test Method for Semi-Guided Bend Test for Ductility of Metallic Materials[4]

E 407 Test Methods for Microetching Metals and Alloys[4]

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[8]

E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis[8]

E 1004 Test Method for Electromagnetic (Eddy-Current) Measurements of Electrical Conductivity[9]

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[8]

G 34 Test Method for Exfoliation Corrosion Susceptibility in 7XXX Series Copper-Containing Aluminum Alloys (Exco Test)[10]

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

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[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SB-209 in Section II of that Code.

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

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

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

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

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

[8] *Annual Book of ASTM Standards*, Vol 03.06.

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

[10] The applicable edition in the use of this specification is G 34-72, which is available in the Related Materials section (gray pages) of the *Annual Book of ASTM Standards*, Vol 02.02.

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

G 47 Test Method for Determining Susceptibility to Stress-Corrosion Cracking of High Strength Aluminum Alloy Products[11]

G 66 Test Method for Visual Assessment of Exfoliation Corrosion Susceptibility of 5XXX Series Aluminum Alloys (Asset Test)[11]

2.3 *ANSI Standards:*

H35.1 Alloy and Temper Designation Systems for Aluminum[12]

H35.2 Dimensional Tolerances for Aluminum Mill Products[12]

2.4 *AMS Specification:*

AMS 2772 Heat Treatment of Aluminum Alloy Raw Materials[13]

3. Terminology

3.1 *Definitions:*

3.1.1 *sheet*—a rolled product that is rectangular in cross section with thickness less than 0.250 in. but not less than 0.006 in. and with slit, sheared, or sawed edges.

3.1.2 *alclad sheet*—composite sheet comprised of an aluminum-alloy core having on both surfaces (if on one side only, alclad one-side sheet) a metallurgically bonded aluminum or aluminum-alloy coating that is anodic to the core, thus electrolytically protecting the core against corrosion.

3.1.3 *coiled sheet*—sheet in coils with slit edges.

3.1.4 *flat sheet*—sheet with sheared, slit, or sawed edges, which has been flattened or leveled.

3.1.5 *mill finish sheet*—sheet having a nonuniform finish which may vary from sheet to sheet and within a sheet, and may not be entirely free from stains or oil.

3.1.6 *one-side bright mill finish sheet*—sheet having a moderate degree of brightness on one side, and a mill finish on the other.

3.1.7 *standard one-side bright finish sheet*— sheet having a uniform bright finish on one side, and a mill finish on the other.

3.1.8 *standard two-sides bright finish sheet*— sheet having a uniform bright finish on both sides.

3.1.9 *plate*—a rolled product that is rectangular in cross section with thickness not less than 0.250 in., and with sheared or sawed edges.

3.1.10 *alclad plate*—composite plate comprised of an aluminum-alloy core having on both surfaces (if on one side only, alclad one-side plate) a metallurgically bonded aluminum or aluminum alloy coating that is anodic to the core, thus electrolytically protecting the core against corrosion.

3.1.11 *parent coil or plate*—a coil of sheet or a plate that has been processed to final temper as a single unit and subsequently cut into two or more smaller coils or individual sheets or into smaller plates to provide the required width or length, or both.

3.1.12 *producer*—the primary manufacturer of the material.

3.1.13 *supplier*—includes only the category of jobbers and distributors as distinct from producers.

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 testing by the purchaser establish that the material does not meet these 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 (7.1),

4.1.4 Temper (9.1),

4.1.5 Finish for sheet in nonheat-treatable alloys (Section 1),

4.1.6 For sheet, whether flat or coiled,

4.1.7 Dimensions (thickness, width, and length or coil size),

4.1.8 Tensile property limits and dimensional tolerances for sizes not covered in Table 2 or Table 3 of this specification and in ANSI H35.2, respectively.

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

4.2.1 Whether supply of one of the pairs of tempers where shown in Table 2, H14 or H24, H34 or H24 is specifically excluded (Table 2, footnote *D*),

4.2.2 Whether heat treatment in accordance with Practice B 597B 597 is required (8.2),

4.2.3 Whether bend tests are required (12.1),

4.2.4 Whether testing for stress-corrosion cracking resistance of alloy 2124-T851 is required (13.1),

4.2.5 Whether ultrasonic inspection for aerospace or pressure vessel applications is required (Section 17),

4.2.6 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (18.1),

4.2.7 Whether certification is required (Section 22),

4.2.8 Whether marking for identification is required (20.1), and

4.2.9 Whether Practices B 660B 660 applies and, if so, the levels of preservation, packaging, and packing required (23.121.1).

5. Responsibility for Quality Assurance

5.1 *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.

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

[11] *Annual Book of ASTM Standards*, Vol 03.02.

[12] Available in the Related Materials section (gray pages) of the *Annual Book of ASTM Standards*, Vol 02.02.

[13] Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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

Alloy	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Zinc	Titanium	Other Elements[D]		Aluminum
									Each	Total[E]	
1060	0.25	0.35	0.05	0.03	0.03	...	0.05	0.03	0.03[F]	...	99.60 min[G]
1100	0.95 Si + Fe		0.05–0.20	0.05	...	...	0.10	...	0.05	0.15	99.00 min[G]
1230[H]	0.70 Si + Fe		0.10	0.05	0.05	...	0.10	0.03	0.03[F]	...	99.30 min[G]
2014	0.50–1.2	0.7	3.9–5.0	0.40–1.2	0.20–0.8	0.10	0.25	0.15	0.05	0.15	remainder
Alclad 2014						2014 clad with 6003					
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
Alclad 2024						2024 clad with 1230					
2124	0.20	0.30	3.8–4.9	0.30–0.9	1.2–1.8	0.10	0.25	0.15	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[I]	0.15[I]	remainder
Alclad 2219						2219 clad with 7072					
3003	0.6	0.7	0.05–0.20	1.0–1.5	...	...	0.10	...	0.05	0.15	remainder
Alclad 3003						3003 clad with 7072					
3004	0.30	0.7	0.25	1.0–1.5	0.8–1.3	...	0.25	...	0.05	0.15	remainder
Alclad 3004						3004 clad with 7072					
3005	0.6	0.7	0.30	1.0–1.5	0.20–0.6	0.10	0.25	0.10	0.05	0.15	remainder
3105	0.6	0.7	0.30	0.30–0.8	0.20–0.8	0.20	0.40	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
5010	0.40	0.7	0.25	0.10–0.30	0.20–0.6	0.15	0.30	0.10	0.05	0.15	remainder
5050	0.40	0.7	0.20	0.10	1.1–1.8	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
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
5086	0.40	0.50	0.10	0.20–0.7	3.5–4.5	0.05–0.25	0.25	0.15	0.05	0.15	remainder
5154	0.25	0.40	0.10	0.10	3.1–3.9	0.15–0.35	0.20	0.20	0.05	0.15	remainder
5252	0.08	0.10	0.10	0.10	2.2–2.8	...	0.05	...	0.03[F]	0.10[F]	remainder
5254	0.45 Si + Fe		0.05	0.01	3.1–3.9	0.15–0.35	0.20	0.05	0.05	0.15	remainder
5454	0.25	0.40	0.10	0.50–1.0	2.4–3.0	0.05–0.20	0.25	0.20	0.05	0.15	remainder
5456	0.25	0.40	0.10	0.50–1.0	4.7–5.5	0.05–0.20	0.25	0.20	0.05	0.15	remainder
5457	0.08	0.10	0.20	0.15–0.45	0.8–1.2	...	0.05	...	0.03[F]	0.10[F]	remainder
5652	0.40 Si + Fe		0.04	0.01	2.2–2.8	0.15–0.35	0.10	...	0.05	0.15	remainder
5657	0.08	0.10	0.10	0.03	0.6–1.0	...	0.05	...	0.02[J]	0.05[J]	remainder
6003[H]	0.35–1.0	0.6	0.10	0.8	0.8–1.5	0.35	0.20	0.10	0.05	0.15	remainder
6013	0.6–1.0	0.50	0.6–1.1	0.20–0.8	0.8–1.2	0.10	0.25	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
Alclad 6061						6061 clad with 7072					
7008[H]	0.10	0.10	0.05	0.05	0.7–1.4	0.12–0.25	4.5–5.5	0.05	0.05	0.10	remainder
7072[H]	0.7 Si + Fe		0.10	0.10	0.10	...	0.8–1.3	...	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	0.05	0.15	remainder
Alclad 7075						7075 clad with 7072					
7008 Alclad 7075						7075 clad with 7008					
7178	0.40	0.50	1.6–2.4	0.30	2.4–3.1	0.18–0.28	6.3–7.3	0.20	0.05	0.15	remainder
Alclad 7178						7178 clad with 7072					

[A] Limits are in weight percent maximum unless shown as a range or stated otherwise.
[B] Analysis shall be made for the elements for which limits are shown in this table.
[C] For purposes of determining conformance to these limits, an observed value or a calculated value attained from analysis shall be rounded to the nearest unit in the last righthand place of figures used in expressing the specified limit, in accordance with the rounding-off method of Practice E 29E 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] Vanadium 0.05 max. The total for other elements does not include vanadium.
[G] 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.
[H] Composition of cladding alloy as applied during the course of manufacture. Samples from finished sheet or plate shall not be required to conform to these limits.
[I] Vanadium 0.05–0.15, zirconium 0.10–0.25. The total for other elements does not include vanadium and zirconium.
[J] Gallium 0.03 max, vanadium 0.05 max. The total for other elements does not include vanadium or gallium.

5.2.1 For heat-treated tempers, an inspection lot shall consist of an identifiable quantity of material of the same mill form, alloy, temper, and thickness traceable to a heat-treat lot or lots, and subjected to inspection at one time.

5.2.2 For nonheat-treated tempers, an inspection lot shall consist of an identifiable quantity of material of the same mill form, alloy, temper, and thickness subjected to inspection at one time.

6. General Quality

6.1 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.

6.2 Each sheet and plate shall be examined to determine conformance to this specification with respect to general quality and identification marking. On approval of the purchaser, however, the producer may use a system of statistical quality control for such examinations.

7. Chemical Composition

7.1 *Limits*—The sheet and plate shall conform to the chemical composition limits specified in Table 1. Conformance shall

be determined by the producer by analyzing samples taken at the time the ingots are cast, or samples taken from the finished or semifinished product. If the producer has determined the chemical composition of the material during the course of manufacture, additional sampling and analysis of the finished product shall not be required.

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 cast, at least one sample shall be taken for each group of ingots cast simultaneously from the same source of molten metal.

7.2.2 When samples are taken from the finished or semifinished product, a sample shall be taken to represent each 4000 lb, or fraction thereof, of material in the lot, except that not more than one sample shall be required per piece.

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 by drilling, sawing, milling, turning, or clipping a representative piece or pieces to obtain a prepared sample of not less than 75 g. Sampling shall be in accordance with Practice E 55E 55.

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

NOTE 4—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.

7.4 *Methods of Analysis*—The determination of chemical composition shall be made in accordance with suitable chemical (Test Methods E 34E 34), or spectrochemical (Test Methods E 227, E 607, and E 1251E 227E 607E 1251) methods. Other methods may be used only when no published ASTM method is available. In case of dispute, the methods of analysis shall be agreed upon between the producer and purchaser.

8. Heat Treatment

8.1 Unless specified in 8.2, producer or supplier heat treatment for the applicable tempers in Table 3 shall be in accordance with AMS 2772.

8.2 When specified, heat treatment of applicable tempers in Table 3 shall be in accordance with Practice B 597B 597.

9. Tensile Properties of Material as Supplied

9.1 *Limits*—The sheet and plate shall conform to the requirements for tensile properties as specified in Table 2 and Table 3 for nonheat-treatable and heat-treatable alloys, respectively.

9.1.1 Tensile property limits for sizes not covered in Table 2 or Table 3 shall be as agreed upon between the producer and purchaser and shall be so specified in the contract or purchase order.

9.2 *Number of Samples*—One sample shall be taken from each end of each parent coil, or parent plate, but no more than one sample per 2000 lb of sheet or 4000 lb of plate, or part thereof, in a lot shall be required. Other procedures for selecting samples may be employed if agreed upon between the producer and purchaser.

9.3 *Test Specimens*—Geometry of test specimens and the location in the product from which they are taken shall be as specified in Test Methods B 557B 557.

9.4 *Test Methods*—The tension test shall be made in accordance with Test Methods B 557B 557.

10. Producer Confirmation of Heat-Treat Response

10.1 In addition to the requirements of 9.1, material in the O or F temper of alloys 2014, Alclad 2014, 2024, Alclad 2024, 1½ % Alclad 2024, Alclad one-side 2024, 1½ % Alclad one-side 2024, 6061, and Alclad 6061 shall, upon proper solution heat treatment and natural aging at room temperature, develop the properties specified in Table 3 for T42 temper material. The natural aging period at room temperature shall be not less than 4 days, but samples of material may be tested prior to 4 days aging, and if the material fails to conform to the requirements of T42 temper material, the tests may be repeated after completion of 4 days aging without prejudice.

10.2 Also, material in the O or F temper of alloys 2219, Alclad 2219, 6061, 7075, Alclad 7075, Alclad one-side 7075, 7008 Alclad 7075, 7178, and Alclad 7178 shall, upon proper solution heat treatment and precipitation heat treatment, develop the properties specified in Table 3 for T62 temper material.

10.3 Mill-produced material in the O or F tempers of 7008 Alclad 7075 shall, upon proper solution heat treatment and stabilizing, be capable of attaining the properties specified in Table 3 for the T76 temper.

10.4 *Number of Specimens*—The number of specimens from each lot of O temper material and F temper material to be tested to verify conformance with 10.1-10.3 shall be as specified in 9.2.

11. Heat Treatment and Reheat-Treatment Capability

11.1 Mill-produced material in the O or F temper of alloys 2014, Alclad 2014, 2024, Alclad 2024, 1½ % Alclad 2024, Alclad one-side 2024, 1½ % Alclad one-side 2024, 6061, and Alclad 6061 (without the subsequent imposition of cold work or forming operations) shall, upon proper solution heat treatment and natural aging at room temperature, develop the properties specified in Table 3 for T42 temper material. The

natural aging period at room temperature shall be not less than 4 days, but samples of material may be tested prior to 4 days aging, and if the material fails to conform to the requirements of T42 temper material, the tests may be repeated after completion of 4 days aging without prejudice.

11.2 Mill-produced material in the O or F temper of alloys 2219, Alclad 2219, 6061, 7075, Alclad 7075, Alclad one-side 7075, 7008 Alclad 7075, 7178, and Alclad 7178 (without the subsequent imposition of cold work or forming operations) shall, upon proper solution heat treatment and precipitation heat treatment, develop the properties specified in Table 3 for T62 temper material.

11.3 Mill-produced material in the O or F temper of 7008 Alclad 7075 (without the subsequent imposition of cold work or forming operations) shall, upon proper solution heat treatment and stabilizing, be capable of attaining the properties specified in Table 3 for the T76 temper.

11.4 Mill-produced material in the following alloys and tempers shall, after proper resolution heat treatment and natural aging for four days at room temperature, be capable of attaining the properties specified in Table 3 for the T42 temper.

Alloys	Tempers
2014 and Alclad 2014	T3, T4, T451, T6, T651
2024 and Alclad 2024	T3, T4, T351, T81, T851
1½ % Alclad 2024, Alclad One-side 2024 and 1½ % Alclad One-side 2024	T3, T351, T81, T851

NOTE 5—Beginning with the 1974 revision 6061 and Alclad 6061 T4, T451, T6, and T651 were deleted from this paragraph because experience has shown that reheat-treated material may develop large recrystallized grains and may fail to develop the tensile properties shown in Table 3.

11.5 Mill-produced material in the following alloys and tempers shall, after proper resolution heat treatment and precipitation heat treatment, be capable of attaining the properties specified in Table 3 for the T62 temper.

Alloys	Tempers
2219 and Alclad 2219	T31, T351, T81, T851
7075	T6, T651, T73, T7351, T76, T7651
Alclad 7075, 7008 Alclad 7075, 7178, and Alclad 7178	T6, T651, T76, T7651
Alclad One-side 7075	T6, T651

11.6 Mill-produced material in the following alloys and tempers and T42 temper material shall, after proper precipitation heat treatment, be capable of attaining the properties specified in Table 3 for the aged tempers listed below.

Alloy and Temper	Temper after Aging
2014 and Alclad 2014-T3, T4, T42, T451	T6, T6, T respectively
2024, Alclad 2024, 1½ % Alclad 2024, Alclad One-side 2024 and 1½ % Alclad One-side 2024-T3, T351, T361, T42	T81, T851, T861, T62 or T72, respectively
2219 and Alclad 2219-T31, T351, T37	T81, T851, T87, respectively
6061 and Alclad 6061-T4, T451, T42	T6, T651, T62, respectively

12. Bend Properties

12.1 *Limits*—Sheet and plate shall be capable of being bent cold through an angle of 180° around a pin having a diameter equal to *N* times the thickness of the sheet or plate without cracking, the value of *N* being as prescribed in Table 2 for the different alloys, tempers, and thicknesses. The test need not be conducted unless specified on the purchase order.

12.2 *Test Specimens*—When bend tests are made, the specimens for sheet shall be the full thickness of the material, approximately ¾ in. in width, and when practical, at least 6 in. in length. Such specimens may be taken in any direction and their edges may be rounded to a radius of approximately 1/16 in. if desired. For sheet less than ¾ in. in width, the specimens should be the full width of the material.

12.3 *Test Methods*—The bend tests shall be made in accordance with Test Method E 290E 290 except as stated otherwise in 12.2.

13. Stress-Corrosion Resistance

13.1 When specified on the purchase order or contract, alloy 2124-T851, 2219-T851, and 2219-T87 plate shall be subjected to the test specified in 13.3 and shall exhibit no evidence of stress-corrosion cracking. One sample shall be taken from each parent plate in each lot and a minimum of three adjacent replicate specimens from this sample shall be tested. The producer shall maintain records of all lot acceptance test results and make them available for examination at the producer's facility.

13.2 Alloy 7075 in the T73-type and T76-type tempers, and alloys Alclad 7075, 7008 Alclad 7075, 7178, and Alclad 7178 in the T76-type tempers, shall be capable of exhibiting no evidence of stress-corrosion cracking when subjected to the test specified in 13.3.

13.2.1 For lot-acceptance purposes, resistance to stress-corrosion cracking for each lot of material shall be established by testing the previously selected tension-test samples to the criteria shown in Table 4.

13.2.2 For surveillance purposes, each month the producer shall perform at least one test for stress-corrosion resistance in accordance with 13.3 on each applicable alloy-temper for each thickness range 0.750 in. and over listed in Table 3, produced that month. Each sample shall be taken from material considered acceptable in accordance with lot-acceptance criteria of Table 4. 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.

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

13.3.1 Specimens shall be stressed in tension in the short transverse direction with respect to grain flow and held at constant strain. For alloy 2124-T851, the stress levels shall be 50 % of the specified minimum long transverse yield strength. For alloy 2219-T851 and T87, the stress levels shall be 75 % of the specified minimum long transverse yield strength. For T73-type tempers, the stress level shall be 75 % of the specified minimum yield strength and for T76-type it shall be 25 ksi.

13.3.2 The stress-corrosion test shall be made in accordance with Test Method G 47G 47.

13.3.3 There shall be no visual evidence of stress-corrosion cracking in any specimen, except that the retest provisions of 19.2 shall apply.

14. Exfoliation-Corrosion Resistance

14.1 Alloys 5083, 5086, and 5456 in the H116 temper shall be capable of exhibiting no evidence of exfoliation corrosion when subjected to the test described in Test Method G 66G 66.

NOTE 6—Alloys 5083, 5086, and 5456 should not be used for continuous service at temperatures exceeding 150°F because of susceptibility to stress corrosion cracking. In addition, stress corrosion susceptibility is increased by cold forming.

14.1.1 For lot-acceptance purposes, the acceptability of each lot of material in the alloys and temper listed in 14.1 shall be determined by the producer by metallographic examination of one sample per lot selected from midsection at one end of a random sheet or plate. The microstructure of the sample from each production lot shall be compared to that of a producer-established reference photomicrograph of acceptable material in the same thickness range which is characterized by being predominantly free of a continuous grain boundary network of aluminum-magnesium (Mg_2Al_3) precipitate. A reference photomicrograph taken at 500× shall be established for each of the thickness ranges shown in Table 2 in which materials are produced and shall be taken from a sample within that thickness range. A longitudinal section perpendicular to the rolled surface shall be prepared for metallographic examination (see Methods E 3E 3, symbol E in Fig. 1) and shall be microetched for metallographic examination using 40 % phosphoric acid etch for 3 min at 95°F or using etchant No. 6 in accordance with Test Methods E 407E 407, Table 2, for 2 min. The metallographic examination shall be conducted at 500× magnification. If the microstructure shows evidence of aluminum-magnesium precipitate in excess of the producer-established reference photomicrograph of acceptable material, the lot is either rejected or tested for exfoliation-corrosion resistance in accordance with 14.1. The sample for corrosion test should be selected in the same manner specified for metallographic tests and shall be taken from the same sheet or plate used for metallographic test. Specimens prepared from the sample shall be full section thickness, except that for material 0.101 in. or more in thickness, 10 % of the thickness shall be removed, by machining, from one as-rolled surface. Both the machined surface and the remaining as-rolled surface shall be evaluated after exposure to the test solution. Production practices shall not be changed after establishment of the reference micrograph except as provided in 14.1.3.

14.1.2 The producer shall maintain at the producing facility all records relating to the establishment of reference photomicrographs and production practices.

14.1.3 Significant changes in production practices that alter the microstructures of the alloy shall require qualification of the practice in accordance with 14.1.1.

14.2 Alloys 7075, Alclad 7075, 7008 Alclad 7075, 7178, and Alclad 7178, in the T76-type tempers, shall be capable of exhibiting no evidence of exfoliation corrosion equivalent to or in excess of that illustrated by Category B in Fig. 2 of Method of Test for Exfoliation Corrosion Susceptibility in 7XXX Series Copper Containing Aluminum Alloys (Exco Test) (G34-72)G 34[13] when subjected to the test in 14.3.

14.2.1 For lot-acceptance purposes, resistance to exfoliation corrosion for each lot of material in the alloys and tempers listed in 14.2 shall be established by testing the previously selected tension-test samples to the criteria shown in Table 4.

14.2.2 For surveillance purposes, each month the producer shall perform at least one test for exfoliation-corrosion resistance for each alloy for each thickness range listed in Table 3, produced that month. The samples for test shall be selected at random from material considered acceptable in accordance with the lot-acceptance criteria of Table 4. The producer shall maintain records of all surveillance test results and make them available for examination.

14.3 The test for exfoliation-corrosion resistance shall be made in accordance with Method of Test for Exfoliation Corrosion Susceptibility in 7XXX Series Copper Containing Aluminum Alloys (Exco Test) (G34-72)[13] and the following:

14.3.1 The specimens shall be a minimum of 2 in. by 4 in. with the 4-in. dimension in a plane parallel to the direction of final rolling. They shall be full-section thickness specimens of the material except that for material 0.101 in. or more in thickness, 10 % of the thickness shall be removed by machining one surface. The cladding of alclad sheet of any thickness shall be removed by machining the test surface; the cladding on the back side (nontest surface) of the specimen for any thickness of alclad material shall also either be removed or masked off. For machined specimens, the machined surface shall be evaluated by exposure to the test solution.

15. Cladding

15.1 Preparatory to rolling alclad sheet and plate to the specified thickness, the aluminum or aluminum-alloy plates which are bonded to the alloy ingot or slab shall be of the composition shown in Table 1 and shall each have a thickness not less than that shown in Table 5 for the alloy specified.

15.2 When the thickness of the cladding is to be determined on finished material, not less than one transverse sample approximately ¾ in. in length shall be taken from each edge and from the center width of the material. Samples shall be mounted to expose a transverse cross section and shall be polished for examination with a metallurgical microscope. Using 100× magnification, the maximum and minimum cladding thickness on each surface shall be measured in each of five fields approximately 0.1 in. apart for each sample. The average of the ten values (five minima plus five maxima) on each sample surface is the average cladding thickness and shall meet the minimum average and, when applicable, the maximum average specified in Table 5.

16. Dimensional Tolerances

16.1 *Thickness*—The thickness of flat sheet, coiled sheet, and plate shall not vary from that specified by more than the respective permissible variations prescribed in Tables 3.1 and Tables 3.13 of ANSI H35.2. Permissible variations in thickness of plate specified in thicknesses exceeding 6 in. shall be the subject of agreement between the purchaser and the producer or the supplier at the time the order is placed.

16.2 *Length, Width, Lateral Bow, Squareness, and Flatness*—Coiled sheet shall not vary in width or in lateral bow from that specified by more than the permissible variations prescribed in Tables 3.5 and Tables 3.6, respectively, of ANSI H35.2. Flat sheet and plate shall not vary in width, length,

lateral bow, squareness, or flatness by more than the permissible variations prescribed in the following tables of ANSI H35.2 except that where the tolerances for sizes ordered are not covered by this standard the permissible variations shall be the subject of agreement between the purchaser and the producer or the supplier at the time the order is placed:

Table No.	Title
3.2	width, sheared flat sheet and plate
3.3	width and length, sawed flat sheet and plate
3.4	length, sheared flat sheet and plate
3.7	lateral bow, flat sheet and plate
3.8	squareness, flat sheet and plate
3.11	flatness, flat sheet
3.12	flatness, sawed or sheared plate

16.3 Dimensional tolerances for sizes not covered in ANSI H35.2 shall be as agreed upon between the producer and purchaser and shall be so specified in the contract or purchase order.

16.4 *Sampling for Inspection*—Examination for dimensional conformance shall be made to ensure conformance to the tolerance specified.

17. Internal Quality

17.1 When specified by the purchaser at the time of placing the order, plate 0.500 in. to 4.500 in. in thickness and up to 2000 lb in maximum weight in alloys 2014, 2024, 2124, 2219, 7075, and 7178, both bare and Alclad where applicable, shall be tested in accordance with Practice B 594B 594 to the discontinuity acceptance limits of Table 6.

17.2 When specified by the purchaser at the time of placing the order, plate 0.500 in. in thickness and greater for ASME pressure vessel applications in alloys 1060, 1100, 3003, Alclad 3003, 3004, Alclad 3004, 5052, 5083, 5086, 5154, 5254, 5454, 5456, 5652, 6061, and Alclad 6061 shall be tested in accordance with Method B 548B 548. In such cases the material will be subject to rejection if the following limits are exceeded unless it is determined by the purchaser that the area of the plate containing significant discontinuities will be removed during the subsequent fabrication process or that the plate may be repaired by welding:

17.2.1 If the longest dimension of the marked area representing a discontinuity causing a complete loss of back reflection (95 % or greater) exceeds 1.0 in.

17.2.2 If the length of the marked area representing a discontinuity causing an isolated ultrasonic indication without a complete loss of back reflection (95 % or greater) exceeds 3.0 in.

17.2.3 If each of two marked areas representing two adjacent discontinuities causing isolated ultrasonic indications without a complete loss of back reflection (95 % or greater) is longer than 1.0 in., and if they are located within 3.0 in. of each other.

18. Source Inspection

18.1 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.

18.2 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 no unnecessary interference with the producer's operations.

19. Retest and Rejection

19.1 If any material fails to conform to all of the applicable requirements of this specification, the inspection lot shall be rejected.

19.2 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.

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

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

20. Identification Marking of Product

20.1 When specified on the purchase order or contract, all sheet and plate shall be marked in accordance with Practice B 666B 666/B 666M.

20.2 In addition, alloys in the 2000 and 7000 series in the T3-, T4-, T6-, T7-, and T8-type tempers and, when specified, 6061-T6 and T651 shall be marked with the lot number in at least one location on each piece.

20.3 The requirements specified in 20.1 and 20.2 are minimum; marking systems that involve added information, larger characters, and greater frequencies are acceptable under this specification.

21. Packaging and Package Marking

21.1 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 packaging and gross weight of containers shall, unless otherwise agreed, be at the producer's or supplier'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.

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

21.3 When specified in the contract or purchase order, material shall be preserved, packaged, and packed in accordance with the requirements of Practices B 660B 660. The applicable levels shall be as specified in the contract or order.

22. Certification

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

23. Keywords

23.1 aluminum alloy; aluminum-alloy plate; aluminum-alloy sheet

TABLE 2 Mechanical Property Limits for Nonheat-Treatable Alloy[A,B]

Temper	Specified Thickness, in.	Tensile Strength, ksi		Yield Strength (0.2 % offset), ksi		Elongation in 2 in. or 4 × Diameter, min, %	Bend Diameter Factor, *N*
		min	max	min	max		
			Aluminum 1060				
O	0.006–0.019	8.0	14.0	2.5	...	15	...
	0.020–0.050	8.0	14.0	2.5	...	22	...
	0.051–3.000	8.0	14.0	2.5	...	25	...
H12[C]	0.017–0.050	11.0	16.0	9.0	...	6	...
or	0.051–2.000	11.0	16.0	9.0	...	12	...
H22[C]							
H14[C]	0.009–0.019	12.0	17.0	10.0	...	1	...
or	0.020–0.050	12.0	17.0	10.0	...	5	..
H24[C]	0.051–1.000	12.0	17.0	10.0	...	10	...
H16[C]	0.006–0.019	14.0	19.0	11.0	...	1	...
or	0.020–0.050	14.0	19.0	11.0	...	4	...
H26[C]	0.051–0.162	14.0	19.0	11.0	...	5	...
H18[C]	0.006–0.019	16.0	...	12.0	...	1	...
or	0.020–0.050	16.0	...	12.0	...	3	...
H28[C]	0.051–0.128	16.0	...	12.0	...	4	...
H112	0.250–0.499	11.0	...	7.0	...	10	...
	0.500–1.000	10.0	...	5.0	...	20	...
	1.001–3.000	9.0	...	4.0	...	25	...
F	0.250–3.000	...	...	...	...	...	...
			Aluminum 1100				
O	0.006–0.019	11.0	15.5	3.5	...	15	0
	0.020–0.031	11.0	15.5	3.5	...	20	0
	0.032–0.050	11.0	15.5	3.5	...	25	0
	0.051–0.249	11.0	15.5	3.5	...	30	0
	0.250–3.000	11.0	15.5	3.5	...	28	0
H12[C]	0.017–0.019	14.0	19.0	11.0	...	3	0
or	0.020–0.031	14.0	19.0	11.0	...	4	0
H22[C]	0.032–0.050	14.0	19.0	11.0	...	6	0
	0.051–0.113	14.0	19.0	11.0	...	8	0
	0.114–0.499	14.0	19.0	11.0	...	9	0
	0.500–2.000	14.0	19.0	11.0	...	12	0
H14[C]	0.009–0.012	16.0	21.0	14.0	...	1	0
or	0.013–0.019	16.0	21.0	14.0	...	2	0
H24[C]	0.020–0.031	16.0	21.0	14.0	...	3	0
	0.032–0.050	16.0	21.0	14.0	...	4	0
	0.051–0.113	16.0	21.0	14.0	...	5	0
	0.114–0.499	16.0	21.0	14.0	...	6	0
	0.500–1.000	16.0	21.0	14.0	...	10	0
H16[C]	0.006–0.019	19.0	24.0	17.0	...	1	4
or	0.020–0.031	19.0	24.0	17.0	...	2	4
H26[C]	0.032–0.050	19.0	24.0	17.0	...	3	4
	0.051–0.162	19.0	24.0	17.0	...	4	4
H18[C]	0.006–0.019	22.0	...	...	...	1	...
or	0.020–0.031	22.0	...	...	...	2	...
H28[C]	0.032–0.050	22.0	...	...	...	3	...
	0.051–0.128	22.0	...	...	...	4	...
H112	0.250–0.499	13.0	...	7.0	...	9	...
	0.500–2.000	12.0	...	5.0	...	14	...
	2.001–3.000	11.5	...	4.0	...	20	...
F[D]	0.250–3.000	...	...	...	...	...	...
			Alloy 3003				

TABLE 2 *Continued*

Temper	Specified Thickness, in.	Tensile Strength, ksi		Yield Strength (0.2 % offset), ksi		Elongation in 2 in. or 4 × Diameter, min, %	Bend Diameter Factor, *N*
		min	max	min	max		
O	0.006–0.007	14.0	19.0	5.0	...	14	0
	0.008–0.012	14.0	19.0	5.0	...	18	0
	0.013–0.031	14.0	19.0	5.0	...	20	0
	0.032–0.050	14.0	19.0	5.0	...	23	0
	0.051–0.249	14.0	19.0	5.0	...	25	0
	0.250–3.000	14.0	19.0	5.0	...	23	...
H12[C]	0.017–0.019	17.0	23.0	12.0	...	3	0
or	0.020–0.031	17.0	23.0	12.0	...	4	0
H22[C]	0.032–0.050	17.0	23.0	12.0	...	5	0
	0.051–0.113	17.0	23.0	12.0	...	6	0
	0.114–0.161	17.0	23.0	12.0	...	7	0
	0.162–0.249	17.0	23.0	12.0	...	8	0
	0.250–0.499	17.0	23.0	12.0	...	9	...
	0.500–2.000	17.0	23.0	12.0	...	10	...
H14[C]	0.009–0.012	20.0	26.0	17.0	...	1	0
or	0.013–0.019	20.0	26.0	17.0	...	2	0
H24[C]	0.020–0.031	20.0	26.0	17.0	...	3	0
	0.032–0.050	20.0	26.0	17.0	...	4	0
	0.051–0.113	20.0	26.0	17.0	...	5	0
	0.114–0.161	20.0	26.0	17.0	...	6	2
	0.162–0.249	20.0	26.0	17.0	...	7	2
	0.250–0.499	20.0	26.0	17.0	...	8	...
	0.500–1.000	20.0	26.0	17.0	...	10	...
H16[C]	0.006–0.019	24.0	30.0	21.0	...	1	4
or	0.020–0.031	24.0	30.0	21.0	...	2	4
H26[C]	0.032–0.050	24.0	30.0	21.0	...	3	4
	0.051–0.162	24.0	30.0	21.0	...	4	6
H18[C]	0.006–0.019	27.0	...	24.0	...	1	...
or	0.020–0.031	27.0	...	24.0	...	2	...
H28[C]	0.032–0.050	27.0	...	24.0	...	3	...
	0.051–0.128	27.0	...	24.0	...	4	...
H112	0.250–0.499	17.0	...	10.0	...	8	...
	0.500–2.000	15.0	...	6.0	...	12	...
	2.001–3.000	14.5	...	6.0	...	18	...
F[D]	0.250–3.000	...	...	...	...	...	...
		Alclad Alloy 3003					
O	0.006–0.007	13.0	18.0	4.5	...	14	...
	0.008–0.012	13.0	18.0	4.5	...	18	...
	0.013–0.031	13.0	18.0	4.5	...	20	...
	0.032–0.050	13.0	18.0	4.5	...	23	...
	0.051–0.249	13.0	18.0	4.5	...	25	...
	0.250–0.499	13.0	18.0	4.5	...	23	...
	0.500–3.000	14.0[E]	19.0[E]	5.0[E]	...	23	...
H12[C]	0.017–0.031	16.0	22.0	11.0	...	4	...
or	0.032–0.050	16.0	22.0	11.0	...	5	...
H22[C]	0.051–0.113	16.0	22.0	11.0	...	6	...
	0.114–0.161	16.0	22.0	11.0	...	7	...
	0.162–0.249	16.0	22.0	11.0	...	8	...
	0.250–0.499	16.0	22.0	11.0	...	9	...
	0.500–2.000	17.0[E]	23.0[E]	12.0[E]	...	10	...
H14[C]	0.009–0.012	19.0	25.0	16.0	...	1	...
or	0.013–0.019	19.0	25.0	16.0	...	2	...
H24[C]	0.020–0.031	19.0	25.0	16.0	...	3	...
	0.032–0.050	19.0	25.0	16.0	...	4	...
	0.051–0.113	19.0	25.0	16.0	...	5	...
	0.114–0.161	19.0	25.0	16.0	...	6	...
	0.162–0.249	19.0	25.0	16.0	...	7	...
	0.250–0.499	19.0	25.0	16.0	...	8	...
	0.500–1.000	20.0[E]	26.0[E]	17.0[E]	...	10	...
H16[C]	0.006–0.019	23.0	29.0	20.0	...	1	...
or	0.020–0.031	23.0	29.0	20.0	...	2	...
H26[C]	0.032–0.050	23.0	29.0	20.0	...	3	...

TABLE 2 *Continued*

Temper	Specified Thickness, in.	Tensile Strength, ksi		Yield Strength (0.2 % offset), ksi		Elongation in 2 in. or 4 × Diameter, min, %	Bend Diameter Factor, *N*
		min	max	min	max		
	0.051–0.162	23.0	29.0	20.0	...	4	...
H18	0.006–0.019	26.0	...	...	...	1	...
	0.020–0.031	26.0	...	...	...	2	...
	0.032–0.050	26.0	...	...	...	3	...
	0.051–0.128	26.0	...	...	...	4	...
H112	0.250–0.499	16.0	...	9.0	...	8	...
	0.500–2.000	15.0[E]	...	6.0 [E]	...	12	...
	2.001–3.000	14.5[E]	...	6.0[E]	...	18	...
F[D]	0.250–3.000	...	...	...	...	...	...
		Alloy 3004					
O	0.006–0.007	22.0	29.0	8.5	...	...	...
	0.008–0.019	22.0	29.0	8.5	...	10	0
	0.020–0.031	22.0	29.0	8.5	...	14	0
	0.032–0.050	22.0	29.0	8.5	...	16	0
	0.051–0.249	22.0	29.0	8.5	...	18	0
	0.250–3.000	22.0	29.0	8.5	...	16	...
H32[C]	0.017–0.019	28.0	35.0	21.0	...	1	0
or	0.020–0.031	28.0	35.0	21.0	...	3	1
H22[C]	0.032–0.050	28.0	35.0	21.0	...	4	1
	0.051–0.113	28.0	35.0	21.0	...	5	2
	0.114–2.000	28.0	35.0	21.0	...	6	...
H34[C]	0.009–0.019	32.0	38.0	25.0	...	1	2
or	0.020–0.050	32.0	38.0	25.0	...	3	3
H24[C]	0.051–0.113	32.0	38.0	25.0	...	4	4
	0.114–1.000	32.0	38.0	25.0	...	5	...
H36[C]	0.006–0.007	35.0	41.0	28.0	...	...	...
or	0.008–0.019	35.0	41.0	28.0	...	1	6
H26[C]	0.020–0.031	35.0	41.0	28.0	...	2	6
	0.032–0.050	35.0	41.0	28.0	...	3	6
	0.051–0.162	35.0	41.0	28.0	...	4	8
H38[C]	0.006–0.007	38.0	...	31.0	...	...	...
or	0.008–0.019	38.0	...	31.0	...	1	...
H28[C]	0.020–0.031	38.0	...	31.0	...	2	...
	0.032–0.050	38.0	...	31.0	...	3	...
	0.051–0.128	38.0	...	31.0	...	4	...
H112	0.250–3.000	23.0	...	9.0	...	7	...
F[D]	0.250–3.000	...	...	...	...	...	...
		Alclad Alloy 3004					
O	0.006–0.007	21.0	28.0	8.0	...	...	...
	0.008–0.019	21.0	28.0	8.0	...	10	...
	0.020–0.031	21.0	28.0	8.0	...	14	...
	0.032–0.050	21.0	28.0	8.0	...	16	...
	0.051–0.249	21.0	28.0	8.0	...	18	...
	0.250–0.499	21.0	28.0	8.0	...	16	...
	0.500–3.000	22.0[E]	29.0[E]	8.5[E]	...	16	...
H32[C]	0.017–0.019	27.0	34.0	20.0	...	1	...
or	0.020–0.031	27.0	34.0	20.0	...	3	...
H22[C]	0.032–0.050	27.0	34.0	20.0	...	4	...
	0.051–0.113	27.0	34.0	20.0	...	5	...
	0.114–0.249	27.0	34.0	20.0	...	6	...
	0.250–0.499	27.0	34.0	20.0	...	6	...
	0.500–2.000	28.0[E]	35.0[E]	21.0[E]	...	6	...
H34[C]	0.009–0.019	31.0	37.0	24.0	...	1	...
or	0.020–0.050	31.0	37.0	24.0	...	3	...
H24[C]	0.051–0.113	31.0	37.0	24.0	...	4	...
	0.114–0.249	31.0	37.0	24.0	...	5	...
	0.250–0.499	31.0	37.0	24.0	...	5	...
	0.500–1.000	32.0[E]	38.0[E]	25.0[E]	...	5	...