Designation: B429/B429M – 10$^{\varepsilon 1}$

Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube[1]

This standard is issued under the fixed designation B429/B429M; 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.

ε[1] NOTE—Table 1 was corrected editorially in February 2012.

1. Scope*

1.1 This specification covers aluminum-alloy extruded structural pipe and tube in those selected alloys shown in Table 1 and tempers shown in Table 2, and in those standard sizes shown in Tables 3-5, as well as in other nonstandard sizes as agreed upon between the purchaser and supplier. Such pipe and tube is intended for use in structural applications such as highway and bridge rails, chain-link fence posts, handrails, sign structures, awning supports, lighting brackets, etc. Structural pipe and tube is not intended for fluid-carrying applications involving pressure.

NOTE 1—For drawn seamless tube used in pressure applications see Specifications B210 and B210M, for seamless pipe and seamless extruded tube used in pressure applications see Specifications B241/B241M, and for drawn tube and pipe for general purpose applications see Specification B483/B483M.

1.2 Alloy and temper designations are in accordance with ANSI H35.1/H35.1(M). The equivalent Unified Numbering System alloy designations are those of Table 1 preceded by A9, for example, A96061 for alloy 6061 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 *Units*—The values stated in either inch-pound units or SI units are to be regarded separately as standard. SI units are shown in brackets. 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 specification.

1.4.1 While this standard is a combined SI and inch-pound standard, standard pipe sizes are not applicable to SI units, therefore non-rationalized SI units (soft conversions) are shown for reader convenience. Rationalized [hard converted] SI units are shown in brackets while non-rationalized (soft converted) SI units are shown in parentheses.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B210 Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes

B210M Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes (Metric)

B241/B241M Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

B483/B483M Specification for Aluminum and Aluminum-Alloy Drawn Tube and Drawn Pipe for General Purpose Applications

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)

B660 Practices for Packaging/Packing of Aluminum and Magnesium Products

B666/B666M Practice for Identification Marking of Aluminum and Magnesium Products

B807/B807M Practice for Extrusion Press Solution Heat Treatment for Aluminum Alloys

B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products

B918 Practice for Heat Treatment of Wrought Aluminum Alloys

B945 Practice for Aluminum Alloy Extrusions Press Cooled from an Elevated Temperature Shaping Process for Production of T1, T2, T5 and T10–Type Tempers

[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.

Current edition approved June 15, 2010. Published July 2010. Originally approved in 1965. Last previous edition approved in 2006 as B429 – 06. DOI: 10.1520/B0429_B0429M-10.

[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.

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

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

Alloy Designation	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Zinc	Titanium	Other Elements[E]		Aluminum
									Each	Total[F]	
6005	0.6-0.9	0.35	0.10	0.10	0.40-0.6	0.10	0.10	0.10	0.05	0.15	Remainder
6005A[G]	0.50-0.9	0.35	0.30	0.50	0.40-0.7	0.30	0.20	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
6063	0.20–0.6	0.35	0.10	0.10	0.45 – 0.9 †	0.10	0.10	0.10	0.05	0.15	remainder
6082	0.7-1.3	0.50	0.10	0.40-1.0	0.6-1.2	0.25	0.20	0.10	0.05	0.15	Remainder
6105	0.6-1.0	0.35	0.10	0.15	0.45-0.8	0.10	0.10	0.10	0.05	0.15	Remainder

[A] Limits are in percent maximum unless shown as a range.
[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 the figures used in expressing the specified limit, in accordance with the rounding method of Practice E29.
[D] In case there is a discrepancy in the values listed in Table 1 with those listed in the International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys (commonly 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.
[E] *Others* includes all 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.
[F] *Other Elements*—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.
[G] 0.12-0.50 Mn+Cr
† Corrected editorially in February 2012.

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

2.2 *ANSI Standards:*
H35.1/H35.1(M) Alloy and Temper Designations Systems for Aluminum[4]
H35.2 Dimensional Tolerance for Aluminum Mill Products[4]
H35.2(M) Dimensional Tolerance for Aluminum Mill Products [Metric][4]

2.3 *Military Standard:*
MIL-STD-129 Marking for Shipment and Storage[5]

2.4 *Federal Standard:*
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[5]

2.5 *EN Standards*
CEN EN 14242 Aluminum and Aluminum Alloys, Chemical Analysis, Inductively Coupled Plasma Optical Emission Spectral Analysis[6]

[3] The last approved version of this historical standard is referenced on www.astm.org.
[4] Available from Aluminum Association, Inc., 1525 Wilson Blvd., Suite 600, Arlington, VA 22209, 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 European Committee for Standardization (CEN), 36 rue de Stassart, B-1050, Brussels, Belgium, http://www.cenorm.be.

3. Terminology

3.1 *Definitions*—Refer to Terminology B881 for definitions of product terms used in this specification.

3.2 *Metric Sizes*—Note that while this is a combined SI and Metric Units Specification, there are no standard equivalent metric designations for Pipe. Metric sizes are converted and shown only for user convenience.

4. Ordering Information

4.1 Purchase orders (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, pounds, or feet,

4.1.3 Size and schedule number for pipe; outside diameter and wall thickness for extruded tube (see Tables 3-5), and length in feet,

4.1.4 Alloy (Section 8) and temper (Section 9),

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 of the material by the manufacturer is required (Section 15),

4.2.3 Whether marking for identification is required and whether marking in accordance with B666/B666M is required (Section 16),

4.2.4 Whether Practices B660 applies and, if so, the levels of preservation, packaging, and packing required (Section 17), and

4.2.5 Whether heat treatment in accordance with Practice B918 is required (10.3).

TABLE 2 Tensile Property Limits[A,B,C]

Alloy-Temper	Specified Wall Thickness, in. [mm]	Tensile Strength, min, ksi [MPa]°	Yield Strength, min, ksi [MPa][D]	Elongation, min, %		
				In 2 in. or 4 × Diameter[E]	In 50 mm[F]	In 5 × Diameter $(5.65\sqrt{A})^F$
6005-T1	Up thru 0.500 [Up thru12.5]	25.0 [170]	15 [105]	16	16	14
6005-T5	Up thru 0.124 [Up thru 3.20]	38.0 [260]	35.0 [240]	8	8	
	0.125-1.000 [3.20-25.0]	38.0 [260]	35.0 [240]	10	10	9
6005A-T1	Up thru 0.249 [Up thru 6.30]	25.0 [170]	14.5 [100]	15	15	. . .
6005A-T5	Up thru 0.249 [Up thru 6.30]	38.0 [260]	31.0 [215]	7	7	. . .
	0.250-0.999 [6.30-25.00]	38.0 [260]	31.0 [215]	9	9	8
6005A-T61	Up thru 0.249 [Up thru 6.30]	38.0 [260]	35.0 [240]	8	8	. . .
	0.250-1.000 [6.30-25.00]	38.0 [260]	35.0[240]	10	10	9
6061-0	All	22.0 [150] max	16.0 [110] max	16	16	
6061-T1	Up thru 0.625	26.0 [180]	14.0 [95]	16	16	
6061-T4,T4510, T4511	All	26.0 [180]	16.0 [110]	16	16	14
6061-T6, T62, T6510, T6511	Up thru 0.249 [Up thru 6.30]	38.0 [260]	35.0 [240]	8	8	...
	0.250 and over [over 6.30]	38.0 [260]	35.0 [240]	10	10	9
6063-0	All	19 [130] max	...	18	18	
6063-T1	Up thru 0.500 [Up thru 12.50]	17.0 [115]	9.0 [60]	12	12	
	0.501-1.000 [12.50- 25.00]	16.0 [110]	8.0 [55]	12	12	
6063-T4, T42	Up thru 0.500 [Up thru 12.50]	19.0 [130]	10.0 [70]	14	14	12
	0.501-1.000 [over 12.50 thru 25.00]	18.0 [125]	9.0 [60]	14	...	12
6063-T5	Up thru 0.500 [Up thru 12.50]	22.0 [150]	16.0 [110]	8	8	
	0.501-1.000 [12.50- 25.00]	21.0[145]	15.0 [105]	8	8	
6063-T52	Up thru 1.000 [Up thru 25.00]	22.0 [150] 30 [205] max	16.0 [110]- 25.0 [170] max	8	8	
6063-T6, T62	Up thru 0.124 [Up thru 3.20]	30.0 [205]	25.0 [170]	8	8	...
	0.125-1.000 [over 3.20 thru 25.00]	30.0 [205]	25.0 [170]	10	10	9
6082-T6, T6511	0.200-1.000 [5.00-25.00]	45.0 [310]	38.0 [260]	8	8	7
6105-T1	Up thru 0.500 [Up thru12.50]	25.0 [170]	15.0 [105]	16	16	14
6105-T5	Up thru 0.500 [Up thru12.50]	38.0 [260]	35.0 [240]	8	8	7

[A] To determine conformance to this specification, each value for tensile strength and for yield strength shall be rounded-off to the nearest 0.1 ksi and each value for elongation to the nearest 0.5 percent, both in accordance with the rounding-off method of Practice E29.
[B] Specimens shall be tested parallel to the direction of working.
[C] The basis for establishment of mechanical property limits is shown in Annex A1.
[D] For explanation of the SI unit MPa, see Appendix X1.
[E] Elongation of full-section and cut-out sheet-type specimens is measured in 2 in., of cut-out round specimens, in 4 × specimen diameter.
[F] Elongations in 50 mm apply for tube and pipe tested in full section and for sheet-type specimens machined from material up through 12.5 mm thickness having parallel surfaces. Elongation in 5D $(5.65\sqrt{A})$ where D and A are diameter and cross-sectional area of the specimen respectively, apply to round test specimens machined from thicknesses over 12.5 mm.

5. Materials and Manufacture

5.1 The pipe or tube may be produced by extrusion through a bridge/porthole-type die or by other methods at the option of the producer, provided that the resulting products comply with the requirements in this specification.

6. Special Characteristics

6.1 Unless otherwise specified, the pipe or tube shall be supplied with square-cut ends.

7. Responsibility for Quality Assurance

7.1 *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. Except as otherwise specified in the contract or order, 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 at the time the order is placed. The purchaser

TABLE 3 Standard Structural Pipe Diameters, Wall Thicknesses, Weights[A]

Nominal Pipe Size Designation	ANSI Schedule No.[B]	Outside Diameter, in.			Inside Diameter, in.	Wall Thickness, in.			Weight,[C] lb/ft	
		Nom.	Min.	Max.	Nom.	Nom.	Min.	Max.[D]	Nom.	Max.
⅛	40	0.405	0.374	0.420	0.269	0.068	0.060	. . .	0.085	0.091
	80	0.405	0.374	0.420	0.215	0.095	0.083	. . .	0.109	0.118
¼	40	0.540	0.509	0.555	0.364	0.088	0.077	. . .	0.147	0.159
	80	0.540	0.509	0.555	0.302	0.119	0.104	. . .	0.185	0.200
⅜	40	0.675	0.644	0.690	0.493	0.091	0.080	. . .	0.196	0.212
	80	0.675	0.644	0.690	0.423	0.126	0.110	. . .	0.256	0.276
½	5	0.840	0.809	0.855	0.710	0.065	0.053	0.077	0.186	. .
	10	0.840	0.809	0.855	0.674	0.083	0.071	0.095	0.232	. .
	40	0.840	0.809	0.855	0.622	0.109	0.095	. . .	0.294	0.318
	80	0.840	0.809	0.855	0.546	0.147	0.129	. . .	0.376	0.406
	160	0.840	0.809	0.855	0.464	0.188	0.164	. . .	0.453	0.489
¾	5	1.050	1.019	1.065	0.920	0.065	0.053	0.077	0.237	...
	10	1.050	1.019	1.065	0.884	0.083	0.071	0.095	0.297	...
	40	1.050	1.019	1.065	0.824	0.113	0.099	. . .	0.391	0.422
	80	1.050	1.019	1.065	0.742	0.154	0.135	. . .	0.510	0.551
	160	1.050	1.019	1.065	0.612	0.219	0.192	. . .	0.672	0.726
1	5	1.315	1.284	1.330	1.185	0.065	0.053	0.077	0.300	...
	10	1.315	1.284	1.330	1.097	0.109	0.095	0.123	0.486	...
	40	1.315	1.284	1.330	1.049	0.133	0.116	. . .	0.581	0.627
	80	1.315	1.284	1.330	0.957	0.179	0.157	. . .	0.751	0.811
	160	1.315	1.284	1.330	0.815	0.250	0.219	...	0.984	1.062
1¼	5	1.660	1.629	1.675	1.530	0.065	0.053	0.077	0.383	...
	10	1.660	1.629	1.675	1.442	0.109	0.095	0.123	0.625	...
	40	1.660	1.629	1.675	1.380	0.140	0.122	. . .	0.786	0.849
	80	1.660	1.629	1.675	1.278	0.191	0.167	. . .	1.037	1.120
	160	1.660	1.629	1.675	1.160	0.250	0.219	. . .	1.302	1.407
1½	5	1.900	1.869	1.915	1.770	0.065	0.053	0.077	0.441	...
	10	1.900	1.869	1.915	1.682	0.109	0.095	0.123	0.721	...
	40	1.900	1.869	1.915	1.610	0.145	0.127	. . .	0.940	1.015
	80	1.900	1.869	1.915	1.500	0.200	0.175	. . .	1.256	1.357
	160	1.900	1.869	1.915	1.338	0.281	0.246	. . .	1.681	1.815
2	5	2.375	2.344	2.406	2.245	0.065	0.053	0.077	0.555	...
	10	2.375	2.344	2.406	2.157	0.109	0.095	0.123	0.913	...
	40	2.375	2.351	2.399	2.067	0.154	0.135	. . .	1.264	1.365
	80	2.375	2.351	2.399	1.939	0.218	0.191	. . .	1.737	1.876
	160	2.375	2.351	2.399	1.687	0.344	0.301	. . .	2.581	2.788
2½	5	2.875	2.844	2.906	2.709	0.083	0.071	0.095	0.856	...
	10	2.875	2.844	2.906	2.635	0.120	0.105	0.135	1.221	...
	40	2.875	2.846	2.904	2.469	0.203	0.178	. . .	2.004	2.164
	80	2.875	2.846	2.904	2.323	0.276	0.242	. . .	2.650	2.862
	160	2.875	2.846	2.904	2.125	0.375	0.328	. . .	3.464	3.741
3	5	3.500	3.469	3.531	3.334	0.083	0.071	0.095	1.048	...
	10	3.500	3.469	3.531	3.260	0.120	0.105	0.135	1.498	...
	40	3.500	3.465	3.535	3.068	0.216	0.189	...	2.621	2.830
	80	3.500	3.465	3.535	2.900	0.300	0.262	...	3.547	3.830
	160	3.500	3.465	3.535	2.624	0.438	0.383	...	4.955	5.351
3½	5	4.000	3.969	4.031	3.834	0.083	0.071	0.095	1.201	...
	10	4.000	3.969	4.031	3.760	0.120	0.105	0.135	1.720	...
	40	4.000	3.960	4.040	3.548	0.226	0.198	...	3.151	3.403
	80	4.000	3.960	4.040	3.364	0.318	0.278	...	4.326	4.672
4	5	4.500	4.469	4.531	4.334	0.083	0.071	0.095	1.354	...
	10	4.500	4.469	4.531	4.260	0.120	0.105	0.135	1.942	...
	40	4.500	4.455	4.545	4.026	0.237	0.207	3.733	4.031	5.598
	80	4.500	4.455	4.545	3.826	0.337	0.295	...	5.183	7.099
	120	4.500	4.455	4.545	3.624	0.438	0.383	...	6.573	8.409
	160	4.500	4.455	4.545	3.438	0.531	0.465	...	7.786	
5	5	5.563	5.532	5.625	5.345	0.109	0.095	0.123	2.196	...
	10	5.563	5.532	5.625	5.295	0.134	0.117	0.151	2.688	...
	40	5.563	5.507	5.619	5.047	0.258	0.226	...	5.057	5.461
	80	5.563	5.507	5.619	4.813	0.375	0.328	...	7.188	7.763
	120	5.563	5.507	5.619	4.563	0.500	0.438	...	9.353	10.10
	160	5.563	5.507	5.619	4.313	0.625	0.547	...	11.40	12.31

TABLE 3 *Continued*

Nominal Pipe Size Designation	ANSI Schedule No.[B]	Outside Diameter, in.			Inside Diameter, in.	Wall Thickness, in.			Weight,[C] lb/ft	
		Nom.	Min.	Max.	Nom.	Nom.	Min.	Max.[D]	Nom.	Max.
6	5	6.625	6.594	6.687	6.407	0.109	0.095	0.123	2.624	. . .
	10	6.625	6.594	6.687	6.357	0.134	0.117	0.151	3.213	. . .
	40	6.625	6.559	6.691	6.065	0.280	0.245	. . .	6.564	7.089
	80	6.625	6.559	6.691	5.761	0.432	0.378	. . .	9.884	10.67
	120	6.625	6.559	6.691	5.501	0.562	0.492	. . .	12.59	13.60
	160	6.625	6.559	6.691	5.187	0.719	0.629	. . .	15.69	16.94
8	5	8.625	8.594	8.718	8.407	0.109	0.095	0.123	3.429	. . .
	10	8.625	8.594	8.718	8.329	0.148	0.130	0.166	4.635	. . .
	20	8.625	8.539	8.711	8.125	0.250	0.219	. . .	7.735	8.354
	30	8.625	8.539	8.711	8.071	0.277	0.242	. . .	8.543	9.227
	40	8.625	8.539	8.711	7.981	0.322	0.282	. . .	9.878	10.67
	60	8.625	8.539	8.711	7.813	0.406	0.355	. . .	12.33	13.31
	80	8.625	8.539	8.711	7.625	0.500	0.438	. . .	15.01	16.21
	100	8.625	8.539	8.711	7.437	0.594	0.520	. . .	17.62	19.03
	120	8.625	8.539	8.711	7.187	0.719	0.629	. . .	21.00	22.68
	140	8.625	8.539	8.711	7.001	0.812	0.710	. . .	23.44	25.31
	160	8.625	8.539	8.711	6.813	0.906	0.793	. . .	25.84	27.90
10	5	10.750	10.719	10.843	10.482	0.134	0.117	0.151	5.256	. . .
	10	10.750	10.719	10.843	10.420	0.165	0.144	0.186	6.453	. . .
	20	10.750	10.642	10.858	10.250	0.250	0.219	. . .	9.698	10.47
	30	10.750	10.642	10.858	10.136	0.307	0.269	. . .	11.84	12.79
	40	10.750	10.642	10.858	10.020	0.365	0.319	. . .	14.00	15.12
	60	10.750	10.642	10.858	9.750	0.500	0.438	. . .	18.93	20.45
	80	10.750	10.642	10.858	9.562	0.594	0.520	. . .	22.29	24.07
	100	10.750	10.642	10.858	9.312	0.719	0.629	. . .	26.65	28.78
12	5	12.750	12.719	12.843	12.438	0.156	0.136	0.176	7.258	. . .
	10	12.750	12.719	12.843	12.390	0.180	0.158	0.202	8.359	. . .
	20	12.750	12.622	12.878	12.250	0.250	0.219	. . .	11.55	12.47
	30	12.750	12.622	12.878	12.090	0.330	0.289	. . .	15.14	16.35
	40	12.750	12.622	12.878	11.938	0.406	0.355	. . .	18.52	20.00
	60	12.750	12.622	12.878	11.626	0.562	0.492	. . .	25.31	27.33
	80	12.750	12.622	12.878	11.374	0.688	0.602	. . .	30.66	33.11

[A] Soft Metric size conversions shown for reader convenience only. Metric sizes do not exist for standard schedule Pipe.
[B] Schedule 40 is also designated as "standard pipe."
[C] Based on the 6005A, 6061, 6082 alloy densities of 0.098 lb/in.^{3} (U.S. Customary) and 2.70 kg/m^3, (Metric). For alloys 6063, 6005, and 6105 multiply by 0.99 and for alloy 3003 multiply by 1.011.
[D] For Schedule 40, maximum wall thickness is controlled by weight tolerance.

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.

7.2 *Lot Definition*—An inspection lot shall consist of an identifiable quantity of material of the same mill form, alloy, temper, and nominal dimensions traceable to a heat-treat lot or lots, and subjected to inspection at one time.

8. Chemical Composition

8.1 *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 E716 when the ingots are poured, and analyzing those samples in accordance with E607, E1251, E34 or EN 14242. At least one sample shall be taken for each group of ingots poured simultaneously from the same source of molten metal. If the producer has determined the chemical composition during pouring of the ingots, they shall not be required to sample and analyze the finished product.

8.2 *Methods of Sampling*—If it becomes necessary to analyze pipe or tube for conformance to chemical composition limits, the method used to sample pipe or tube for the determination of chemical composition shall be by agreement between the producer and the purchaser. Analysis shall be performed in accordance with E716, E607, E1251, E34 or EN 14242 (ICP method). The number of samples taken for determination of chemical composition shall be as follows:

8.2.1 When samples are taken from pipe or tube, a sample shall be taken to represent each 4000 lb [2000 kg] or fraction thereof of material in the shipment, except that not more than one sample shall be required per piece.

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

NOTE 2—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 3—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

TABLE 4 Standard Structural Pipe Diameters, Wall Thicknesses, Weights,[A] Metric SI Units

Nominal Pipe Size Designation	ANSI Schedule No.[B]	Outside Diameter, mm			Inside Diameter, mm	Wall Thickness, mm			Mass[C] Per Metre g	
		Nom.	Min.	Max.	Nom.	Nom.	Min.	Max.[D]	Nom.	Max.
⅛	40	10.30	9.50	10.70	6.84	1.73	1.51	. . .	0.13	0.14
	80	10.30	9.50	10.70	5.48	2.41	2.11	. . .	0.16	0.17
¼	40	13.70	12.90	14.10	9.22	2.24	1.96	. . .	0.22	0.24
	80	13.70	12.90	14.10	7.66	3.02	2.64	. . .	0.27	0.29
⅜	40	17.10	16.30	17.50	12.48	2.31	2.02	. . .	0.29	0.31
	80	17.10	16.30	17.50	10.70	3.20	2.80	. . .	0.38	0.41
½	40	21.30	20.50	21.70	15.76	2.77	2.42	. . .	0.44	0.48
	80	21.30	20.50	21.70	13.84	3.73	3.26	. . .	0.56	0.60
	160	21.30	20.50	21.70	11.74	4.78	4.18	. . .	0.67	0.72
¾	40	26.70	25.90	27.10	20.96	2.87	2.51	. . .	0.58	0.63
	80	26.70	25.90	27.10	18.88	3.91	3.42	. . .	0.76	0.82
	160	26.70	25.90	27.10	15.58	5.56	4.86	. . .	1.00	1.08
1	40	33.40	32.60	33.80	26.64	3.38	2.96	. . .	0.86	0.93
	80	33.40	32.60	33.80	24.30	4.55	3.98	. . .	1.11	1.20
	160	33.40	32.60	33.80	20.70	6.35	5.56	. . .	1.46	1.58
1 ¼	40	42.20	41.40	42.60	35.08	3.56	3.12	. . .	1.17	1.26
	80	42.20	41.40	42.60	32.50	4.85	4.24	. . .	1.54	1.66
	160	42.20	41.40	42.60	29.50	6.35	5.56	. . .	1.93	2.08
1 ½	40	48.30	47.50	48.70	40.94	3.68	3.22	. . .	1.39	1.50
	80	48.30	47.50	48.70	38.14	5.08	4.44	. . .	1.86	2.01
	160	48.30	47.50	48.70	34.02	7.14	6.25	. . .	2.49	2.69
2	40	60.30	59.70	60.90	52.48	3.91	3.42	. . .	1.87	2.02
	80	60.30	59.70	60.90	49.22	5.54	4.85	. . .	2.57	2.78
	160	60.30	59.70	60.90	42.82	8.74	7.65	. . .	3.82	4.13
2½	40	73.00	72.30	73.70	62.68	5.16	4.52	. . .	2.97	3.21
	80	73.00	72.30	73.70	58.98	7.01	6.13	. . .	3.92	4.23
	160	73.00	72.30	73.70	53.94	9.53	8.34	. . .	5.13	5.54
3	40	88.90	88.00	89.80	77.92	5.49	4.80	. . .	3.88	4.19
	80	88.90	88.00	89.80	73.66	7.62	6.67	. . .	5.25	5.67
	160	88.90	88.00	89.80	66.64	11.13	9.74	. . .	7.34	7.93
3 ½	40	101.60	100.60	102.60	90.12	5.74	5.02	. . .	4.67	5.04
	80	101.60	100.60	102.60	85.44	8.08	7.07	. . .	6.41	6.92

Nominal Pipe Size Designation	ANSI Schedule No.[B]	Outside Diameter, mm			Inside Diameter, mm	Wall Thickness, mm			Mass[C] Per Metre g	
		Nom.	Min.[E]	Max.[E]	Nom.	Nom.	Min.	Max.[D]	Nom.	Max.
4	40	114.30	113.20	115.40	102.26	6.02	5.27	. . .	5.53	5.97
	80	114.30	113.20	115.40	97.18	8.56	7.49	. . .	7.68	8.29
	120	114.30	113.20	115.40	92.04	11.13	9.74	. . .	9.74	10.53
	160	114.30	113.20	115.40	87.32	13.49	11.80	. . .	11.54	12.45
5	40	141.30	139.90	142.70	128.20	6.55	5.73	. . .	7.49	8.09
	80	141.30	139.90	142.70	122.24	9.53	8.34	. . .	10.65	11.50
	120	141.30	139.90	142.70	115.90	12.70	11.11	. . .	13.85	14.96
	160	141.30	139.90	142.70	109.54	15.88	13.90	. . .	16.89	18.24
6	40	168.30	166.60	170.00	154.08	7.11	6.22	. . .	9.72	10.50
	80	168.30	166.60	170.00	146.36	10.97	9.60	. . .	14.64	15.81
	120	168.30	166.60	170.00	139.76	14.27	12.49	. . .	18.64	20.13
	160	168.30	166.60	170.00	131.78	18.26	15.98	. . .	23.24	25.10
8	20	219.10	216.90	221.30	206.40	6.35	5.56	. . .	11.46	12.38
	30	219.10	216.90	221.30	205.02	7.04	6.16	. . .	12.66	13.67
	40	219.10	216.90	221.30	202.74	8.18	7.16	. . .	14.63	15.80
	60	219.10	216.90	221.30	198.48	10.31	9.02	. . .	18.26	19.72
	80	219.10	216.90	221.30	193.70	12.70	11.11	. . .	22.23	24.01
	100	219.10	216.90	221.30	188.92	15.09	13.20	. . .	26.11	28.21
	120	219.10	216.90	221.30	182.58	18.26	15.98	. . .	31.11	33.60
	140	219.10	216.90	221.30	177.86	20.62	18.04	. . .	34.72	37.50
	160	219.10	216.90	221.30	173.08	23.01	20.13	. . .	38.27	41.33

TABLE 4 *Continued*

10	20	273.10	270.40	275.80	260.40	6.35	5.56	. . .	14.37	15.52
	30	273.10	270.40	275.80	257.50	7.80	6.82	. . .	17.55	18.95
	40	273.10	270.40	275.80	254.56	9.27	8.11	. . .	20.75	22.41
	60	273.10	270.40	275.80	247.70	12.70	11.11	. . .	28.05	30.29
	80	273.10	270.40	275.80	242.92	15.09	13.20	. . .	33.02	35.66
	100	273.10	270.40	275.80	236.58	18.26	15.98	. . .	39.47	42.63
12	20	323.90	320.70	327.10	311.20	6.35	5.56	. . .	17.10	18.47
	30	323.90	320.70	327.10	307.14	8.38	7.33	. . .	22.43	24.22
	40	323.90	320.70	327.10	303.28	10.31	9.02	. . .	27.42	28.61
	60	323.90	320.70	327.10	295.36	14.27	12.49	. . .	37.48	40.48
	80	323.90	320.70	327.10	288.94	17.48	15.30	. . .	45.43	49.06

[A] Soft Metric size conversions shown for reader convenience only. Metric sizes do not exist for standard schedule Pipe.
[B] Schedule 40 is also designated as "standard pipe."
[C] Based on the 6005A, 6061, 6082 alloy densities of 0.098 lb/in.^{3}(U.S. Customary) and 2.70 kg/m^3, (Metric). For alloys 6063, 6005, and 6105 multiply by 0.99 and for alloy 3003 multiply by 1.011.
[D] For Schedule 40, maximum wall thickness is controlled by weight tolerance.
[E] For Schedules 5 and 10 these values apply to mean outside diameters.

TABLE 5 Standard Structural Tube Sizes

Outside Diameter, OD, in. [mm]	Nominal Wall Thickness, in. [mm]	Nominal Weight,[A] lb/ft [kg/m]	Outside Diameter, OD, in. [mm]	Wall Thickness, in. [mm]	Nominal Weight,[A] lb/ft [kg/m]
1.500 [40]	0.125 [3.20]	0.631 [1.00]	4.000 [100]	0.125 [3.20]	1.790 [2.63]
	0.188 [5.00]	0.911 [1.48]		0.188 [5.00]	2.650 [4.03]
	0.250 [6.30]	1.150 [1.80]		0.250 [6.30]	3.460 [5.01]
2.000 [50]	0.125 [3.20]	0.866 [1.27]	4.500 [120]	0.125 [3.20]	2.020 [3.17]
	0.188 [5.00]	1.260 [1.91]		0.188 [5.00]	2.990 [4.88]
	0.250 [6.30]	1.620 [2.34]		0.250 [6.30]	3.390 [6.08]
2.500 [60]	0.125 [3.20]	1.100 [1.54]	5.000 [130]	0.125 [3.20]	2.250 [3.44]
	0.188 [5.00]	1.610 [2.33]		0.188 [5.00]	3.340 [5.30]
	0.250 [6.30]	2.080 [2.87]		0.250 [6.30]	4.390 [6.62]
3.000 [80]	0.125 [3.20]	1.330 [2.08]	5.500 [140]	0.188 [5.00]	3.690 [5.73]
	0.188 [5.00]	1.950 [3.18]		0.250 [6.30]	4.850 [7.36]
	0.250 [6.30]	2.540 [3.94]			
3.500 [90]	0.125 [3.20]	1.560 [2.36]	6.000 [150]	0.188 [5.00]	4.040 [6.15]
	0.188 [5.00]	2.300 [3.60]			
	0.250 [6.30]	3.000 [4.48]			

[A] Based on the 6005A, 6061 and 6082 alloy densities of 0.098 lb/in.^{3} (U.S. Customary) and 2.70 kg/m^3, (Metric). For alloys 6005, 6105, and 6063 multiply by 0.99.

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.

9. Tensile Properties

9.1 *Limits*—The material shall conform to the tensile property requirements specified in Table 2.

9.2 *Number of Specimens:*

9.2.1 For material having a nominal weight of less than 1 lb/linear ft [1.60 kg/linear m] one tension test specimen shall be taken for each 1000 lb [454 kg] or fraction thereof in the lot.

9.2.2 For material having a nominal weight of 1 lb or more/linear ft, one tension test specimen shall be taken for each 1000 ft [305 m] or fraction thereof in the lot.

9.2.3 Other procedures for selecting samples may be employed if agreed upon by the producer and the 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 B557 and B557M.

9.4 *Test Methods*—The tension test shall be made in accordance with Test Methods B557 and B557M.

10. Heat Treatment

10.1 Producer or supplier heat treatment for the production of T1 and T5-type tempers shall be in accordance with Practice B945.

10.2 Unless otherwise specified in 10.3, alloys 6061, 6063, 6005A, and 6082 shall be extrusion press solution heat treated in accordance with Practice B807/B807M for the production of T4 and T6-type tempers.

10.3 When specified by order, heat treatment of T4 and T6-type tempers shall be in accordance with Practice B918.

11. Dimensional Tolerances

11.1 Variations from the specified dimensions for the type of material ordered shall not exceed the permissible variations prescribed in the following tables of ANSI H35.2 [H35.2(M)]:

Table No.	Title
(Section)	Extruded Tube and Pipe
12.	
12.2	Diameter, Round Tube
12.4	Wall Thickness, Round Extruded Tube
12.6	Length-Extruded Tube
12.8	Straightness, Extruded Tube in Straight Lengths
12.10	Squareness of Cut Ends-Extruded Tube
	Pipe
12.49	Outside Diameter Tolerances-Extruded Pipe and Extruded and Drawn Pipe
12.50	Wall Thickness Tolerances-Extruded Pipe and Extruded and Drawn Pipe
12.51	Weight Tolerances-Extruded Pipe or Extruded and Drawn Pipe
12.52	Length Tolerances Extruded Pipe and Extruded and Drawn Pipe
12.55	Diameters, Wall Thicknesses, Weights-Pipe

11.2 The maximum and minimum wall thicknesses, outside diameters, and nominal weights of standard sizes of pipe are shown in Table 3 or Table 4.

12. General Quality

12.1 Unless otherwise specified, the material shall be supplied in the mill finish, with plain ends, and shall be uniform as defined by the requirements of this specification and shall be commercially sound. Discoloration that is characteristic of proper solution heat treatment shall not be cause for rejection. Any requirement not so covered is subject to negotiation between producer and purchaser.

12.2 Each length of pipe and tube 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.

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 no 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 retest shall meet the requirements of the specification or the lot shall be subject to rejection.

14.3 Material which is determined to be non-compliant 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 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, upon request, furnish to the purchaser a certificate stating that each lot has been sampled, tested, and inspected in accordance with this specification, and has met the requirements.

16. Identification Marking of Product

16.1 When specified on the purchase order or contract, all pipe and tube 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 packaging and gross weight of containers shall, unless otherwise agreed, be at the producer 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.

17.2 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.

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; extruded pipe; extruded tube

ANNEXES

(Mandatory Information)

A1. BASIS FOR INCLUSION OF PROPERTY LIMITS

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

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 5 cast lots of standard production material with no more than 10 observations from a given heat treat or inspection lot. Mechanical properties limits for press solution heat treated products have specific additional requirements which are provided in the "Tempers for Aluminum and Aluminum Alloy Products".

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[7] 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 the specification.

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

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

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

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

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

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

[7] Available from Aluminum Association, Inc., 1525 Wilson Blvd., Suite 600, Arlington, VA 22209, http://www.aluminum.org.

A3. PART OR IDENTIFYING NUMBERS (PINS) FOR USE BY THE DEPARTMENT OF DEFENSE

A3.1 Part numbers are essential to maintain the integrity of the Department of Defense cataloging system as multiple National Stock Numbers (NSN) exist for this product.

A3.2 Part numbers shall be formulated by selecting from the options in this specification as follows:

B429	-XXXX	-XXXX	-XX	-XX	-XX
Document Identifier	Alloy	Temper	Tube or Pipe size in 0.25 in. increments	Schedule size	Length in ft

A3.3 Examples of part numbers are provided below:

A3.3.1 B429-6063-T6-03-40-20 indicates an ASTM B429 standard structural pipe in 6063 alloy and T6 temper that is ¾-in. pipe size, ANSI schedule 40 with a 20-ft length.

A3.3.2 B429-3003-H18-04-10-10 indicates an ASTM B429 standard structural pipe in 3003 alloy and H18 temper that is 1-in. pipe size, ANSI schedule 10 with a 10 ft length.

APPENDIX

(Nonmandatory Information)

X1. METRIC EQUIVALENTS

X1.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI). The derived SI unit for force is the Newton (N), which is defined as that force which when applied to a body having a mass of one kilogram gives it an acceleration of 1 m/s^2 ($N = kg \cdot m/s^2$). The derived SI unit for pressure or stress is the Newton per square meter (N/m^2), which has been named the Pascal (Pa) by the General Conference on Weights and Measures. Since 1 ksi = 6,894.757 Pa the metric equivalents are expressed as mega Pascal (MPa), which is the same as MN/m^2 and N/mm^2.

SUMMARY OF CHANGES

Changes to this document are too numerous to have all detail listed here as the specification has been substantially rewritten and upgraded to expand sizes and alloys of product covered (Approved June 15, 2010). Main areas of revision:

(1) Referenced documents have been added and corrected to current usage, including addition of B945 for press heat treated T1 and T5 tempers.
(2) In general, the tables of sizes, schedules, weights, etc., have all been expanded to cover the same size ranges as The Aluminum Association's AS & D, Aluminum Standards and Data Book 2006.
(3) Prior Table number references were out of sync with AS & D/ANSI H35.2, and this has been corrected.
(4) Alloys 6005, 6005A, 6082, and 6105 have been added.
(5) Statement regarding Basis for Mechanical Properties and Tentative Registrations added.
(6) Statement that no standard pipe sizes exist for metric products, conversions shown only for reader convenience.
(7) Section 8 on chemical analysis has been replaced with the wording used for Section 7 in B241 for consistency.
(8) Corrected A2.2.7 and A2.1 to standard language.
(9) Standardized Section 10 on Heat Treatment to same wording as other documents.
(10) Added footnote on Mn + Cr in Table 1 for 6005A.
(11) Added 6063-0, 6063-T1, 6063-T5, 6063-T52 (corrected elongations), 6061-0, and 6061-T1 in Table 2.