



Designation: B429/B429M – 20

# Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube<sup>1</sup>

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 ( $\epsilon$ ) 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 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/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/H35.1M. 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 SI units or inch-pound units are to be regarded separately as standard. SI units are shown in brackets. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4.1 *Metric Sizes*—While this is a combined SI and inch-pound units specification, there are no standard equivalent metric designations for pipe. Metric sizes are converted and shown only for user convenience.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B07 on Light Metals and Alloys and is the direct responsibility of Subcommittee B07.03 on Aluminum Alloy Wrought Products.

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1.4.2 While this is a combined SI and inch-pound units specification, 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- B210/B210M** Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes
- 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

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto: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<sup>A,B,C,D</sup>**

Alloy Designation	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Other Elements <sup>E</sup>		Al
									Each	Total <sup>F</sup>	
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	rem
6005A <sup>G</sup>	0.50–0.9	0.35	0.30	0.50	0.40–0.7	0.30	0.20	0.10	0.05	0.15	rem
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	rem
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	rem
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	rem
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	rem

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

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

<sup>C</sup> 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.

<sup>D</sup> In case there is a discrepancy in the values listed in this table 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>.

<sup>E</sup> 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 *Other Elements*. Should any analysis by the producer or the purchaser establish that an *Other Element* exceeds the limit of *Each* or that the aggregate of several *Other Elements* exceeds the limit of *Total*, the material shall be considered nonconforming.

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

<sup>G</sup> 0.12-0.50 Mn+Cr.

**B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products**

**B918/B918M 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**

**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 (Withdrawn 2017)<sup>3</sup>**

**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)<sup>3</sup>**

**E716 Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spark Atomic Emission Spectrometry**

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

**E3061 Test Method for Analysis of Aluminum and Aluminum Alloys by Inductively Coupled Plasma Atomic Emission Spectrometry (Performance Based Method)**

**2.2 ANSI Standards:<sup>4</sup>**

**H35.1/H35.1M Alloy and Temper Designations Systems for Aluminum**

**H35.2 Dimensional Tolerance for Aluminum Mill Products**

**H35.2M Dimensional Tolerance for Aluminum Mill Products [Metric]**

**2.3 Military Standard:<sup>5</sup>**

**MIL-STD-129 Marking for Shipment and Storage**

**2.4 Federal Standard:<sup>5</sup>**

**Fed. Std. No. 123 Marking for Shipment (Civil Agencies)**

**3. Terminology**

**3.1 Definitions:**

3.1.1 Refer to Terminology B881 for definitions of product terms used in this specification.

**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, and

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 Practice 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

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from Aluminum Association, 1400 Crystal Dr., Suite 430, Arlington, VA 22202, <http://www.aluminum.org>.

<sup>5</sup> Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.

**TABLE 2 Tensile Property Limits<sup>A,B,C</sup>**

Alloy-Temper	Specified Wall Thickness, in. [mm]	Tensile Strength, min, ksi [MPa]	Yield Strength, min, ksi [MPa] <sup>D</sup>	Elongation, min, %		
				2 in. or 4× Diameter <sup>E</sup>	50 mm <sup>F</sup>	5× Diameter (5.65√A) <sup>F</sup>
6005-T1	up through 0.500 [up through 12.5]	25.0 [170]	15 [105]	16	16	14
6005-T5	up through 0.124 [up through 3.20]	38.0 [260]	35.0 [240]	8	8	9
	0.125-1.000 [3.20-25.0]	38.0 [260]	35.0 [240]	10	10	
6005A-T1	up through 0.249 [up through 6.30]	25.0 [170]	14.5 [100]	15	15	...
6005A-T5	up through 0.249 [up through 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 through 0.249 [up through 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	0
6061-0	all	22.0 [150] max	16.0 [110] max	16	16	
6061-T1	up through 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 through 0.249 [up through 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 through 0.500 [up through 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 through 12.50]	19.0 [130]	10.0 [70]	14	14	12
	0.501-1.000 [over 12.50 through 25.00]	18.0 [125]	9.0 [60]	14	...	12
6063-T5	up through 0.500 [up through 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 through 1.000 [up through 25.00]	22.0 [150] 30 [205] max	16.0-25.0 [110-170] max	8	8	
6063-T6, T62	up through 0.124 [up through 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 through 0.500 [up through 12.50]	25.0 [170]	15.0 [105]	16	16	14
6105-T5	up through 0.500 [up through 12.50]	38.0 [260]	35.0 [240]	8	8	7

<sup>A</sup> 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 %, both in accordance with the rounding-off method of Practice E29.

<sup>B</sup> Specimens shall be tested parallel to the direction of working.

<sup>C</sup> The basis for establishment of mechanical property limits is shown in Annex A1.

<sup>D</sup> For explanation of the SI unit MPa, see Appendix X1.

<sup>E</sup> Elongation of full-section and cut-out sheet-type specimens is measured in 2 in., of cut-out round specimens, in 4× specimen diameter.

<sup>F</sup> 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√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.

4.2.5 Whether heat treatment in accordance with Practice B918/B918M is required (10.3).

## 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

**B429/B429M – 20****TABLE 3 Standard Structural Pipe Diameters, Wall Thicknesses, Weights<sup>A</sup>**

Nominal Pipe Size Designation	ANSI Schedule No. <sup>B</sup>	Outside Diameter, in.			Inside Diameter, in.	Wall Thickness, in.			Weight, <sup>C</sup> lb/ft	
		Nominal	Minimum	Maximum	Nominal	Nominal	Minimum	Maximum <sup>D</sup>	Nominal	Maximum
1/8	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
1/4	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
3/8	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
1/2	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
3/4	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
1 1/4	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
1 1/2	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
2 1/2	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
3 1/2	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	...

**TABLE 3** *Continued*

Nominal Pipe Size Designation	ANSI Schedule No. <sup>B</sup>	Outside Diameter, in.			Inside Diameter, in.		Wall Thickness, in.			Weight, <sup>C</sup> lb/ft	
		Nominal	Minimum	Maximum	Nominal	Minimum	Maximum <sup>D</sup>	Nominal	Maximum		
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	
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	
120		10.750	10.642	10.858	9.062	0.844	0.731	...	31.01	33.31	
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	
	100	12.750	12.622	12.878	11.122	0.813	0.700	...	36.01	38.51	

<sup>A</sup> Soft metric size conversions shown for reader convenience only. Metric sizes do not exist for standard schedule pipe.

<sup>B</sup> Schedule 40 is also designated as "standard pipe."

<sup>C</sup> Based on the 6005A, 6061, and 6082 alloy densities of 0.098 lb/in.<sup>3</sup> (U.S. customary) and 2.70 kg/m<sup>3</sup> (metric). For alloys 6063, 6005, and 6105 multiply by 0.99. For alloy 3003 multiply by 1.011.

<sup>D</sup> For Schedule 40, maximum wall thickness is controlled by weight tolerance.

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 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 **Practice E716** when the ingots are poured, and analyzing those samples in accordance with **Test Methods E607, E1251, E34, or E3061**. 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** If it becomes necessary to analyze pipe or tube for conformance to chemical composition limits, the methods of sampling and methods of analysis shall be as provided in the following:

**8.2.1 Methods of Sampling**—Samples for chemical analysis shall be taken in accordance with **Practice B985**.

**8.2.2 Methods of Analysis**—Analysis shall be in accordance with **Practice B985**.

**TABLE 4 Standard Structural Pipe Diameters, Wall Thicknesses, Weights,<sup>A</sup> Metric SI Units**

Nominal Pipe Size Designation	ANSI Schedule No. <sup>B</sup>	Outside Diameter, mm			Inside Diameter, mm	Wall Thickness, mm			Mass <sup>C</sup> per m, g	
		Nominal	Minimum <sup>E</sup>	Maximum <sup>E</sup>	Nominal	Nominal	Minimum	Maximum <sup>D</sup>	Nominal	Maximum
1/8	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
1/4	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
3/8	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
1/2	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
3/4	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 1/4	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 1/2	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
2 1/2	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 1/2	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
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*

Nominal Pipe Size Designation	ANSI Schedule No. <sup>B</sup>	Outside Diameter, mm			Inside Diameter, mm	Wall Thickness, mm			Mass <sup>C</sup> per m, g	
		Nominal	Minimum <sup>E</sup>	Maximum <sup>E</sup>	Nominal	Nominal	Minimum	Maximum <sup>D</sup>	Nominal	Maximum
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

<sup>A</sup> Soft metric size conversions shown for reader convenience only. Metric sizes do not exist for standard schedule pipe.

<sup>B</sup> Schedule 40 is also designated as "standard pipe."

<sup>C</sup> Based on the 6005A, 6061, and 6082 alloy densities of 0.098 lb/in.<sup>3</sup> (U.S. customary) [2.70 kg/m<sup>3</sup> (metric)]. For alloys 6063, 6005, and 6105 multiply by 0.99. For alloy 3003 multiply by 1.011.

<sup>D</sup> For Schedule 40, maximum wall thickness is controlled by weight tolerance.

<sup>E</sup> 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, <sup>A</sup> lb/ft [kg/m]	Outside Diameter, OD, in. [mm]	Wall Thickness, in. [mm]	Nominal Weight, <sup>A</sup> 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]			

<sup>A</sup> Based on the 6005A, 6061, and 6082 alloy densities of 0.098 lb/in.<sup>3</sup> (U.S. customary) [2.70 kg/m<sup>3</sup> (metric)]. For alloys 6005, 6105, and 6063 multiply by 0.99.

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 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.