Designation: B210 – 04

Used in USNRC-NDT standards

Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes[1]

This standard is issued under the fixed designation B210; 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.

1. Scope*

1.1 This specification[2] covers aluminum and aluminum-alloy drawn seamless tubes in straight lengths and coils for general purpose and pressure applications in alloys (Note 2), tempers, and thicknesses shown in Table 2. Coiled tubes are generally available only as round tubes with a wall thickness not exceeding 0.083 in. and only in nonheat-treatable alloys.

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 designation 1100 in accordance with Practice E527.

NOTE 1—See Specification B483/B483M for aluminum-alloy drawn tubes for general purpose applications; Specification B234 for aluminum-alloy drawn seamless tubes for condensers and heat exchangers; and Specification B241/B241M for aluminum-alloy seamless pipe and seamless extruded tube.

NOTE 2—Throughout this specification, use of the term *alloy* in the general sense includes aluminum as well as aluminum alloy.

1.3 A complete metric companion to Specification B210 has been developed—Specification B210M; 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.

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

2.2 *ASTM Standards:*[3]

B234 Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes for Condensers and Heat Exchangers

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 Pipe for General Purpose Applications

B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products

B660 Practices for Packaging/Packing of Aluminum and Magnesium Products

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

B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products

B918 Practice for Heat Treatment of Wrought Aluminum Alloys

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

E55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition

E215 Practice for Standardizing Equipment for Electromagnetic Testing of Seamless Aluminum-Alloy Tube

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[4]

E716 Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spectrochemical Analysis

[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-210 in Section II of that Code.

[3] 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.

[4] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

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

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

Alloy	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Zinc	Titanium	Other Elements[D]		Aluminum, min
									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]
2011	0.40	0.7	5.0–6.0	...	...	...	0.30	...	0.05[H]	0.15	remainder
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
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
3003	0.6	0.7	0.05–0.20	1.0–1.5	...	...	0.10	...	0.05	0.15	remainder
Alclad 3003[I]											
3102	0.40	0.7	0.10	0.05–0.40	...	...	0.30	0.10	0.05	0.15	remainder
Alclad 3102[I]											
5005	0.30	0.7	0.20	0.20	0.50–1.1	0.10	0.25	...	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
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
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
6262	0.40–0.8	0.7	0.15–0.40	0.15	0.8–1.2	0.04–0.14	0.25	0.15	0.05[J]	0.15	remainder
7072 cladding[K]	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

[A] Limits are in weight percent maximum unless shown as a range or otherwise stated.
[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 obtained from analysis shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the specified limit, in accordance with the rounding-off method of Practice E29.
[D] *Others* includes listed elements for which no specific limit is shown as well as unlisted metallic elements. The producer may analyze samples for trace elements not specified in 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 non-conforming.
[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.
[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] Bismuth and lead each 0.20–0.6 %.
[I] Alloy clad with Alloy 7072.
[J] Bismuth and lead each 0.40–0.7 %.
[K] Composition of cladding alloy as applied during the course of manufacture. The samples from finished tube shall not be required to conform to these limits.

E1004 Test Method for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method
E1251 Test Method for Analysis of Aluminum and Aluminum Alloys by Spark Atomic Emission Spectrometry

2.3 *ANSI Standards:*[5]
H35.1 Alloy and Temper Designation Systems for Aluminum
H35.2 Dimensional Tolerances for Aluminum Mill Products

2.4 *Military Standard:*[6]
MIL-STD-129 Marking for Shipment and Storage

2.5 *AMS Specification:*[7]
AMS 2772 Heat Treatment of Aluminum Alloy Raw Materials

2.6 *Federal Standard:*[6]
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *capable of*—The term *capable of* as used in this specification means that the test need not be performed by the producer of the material. However, should subsequent testing by the purchaser establish that the material does not meet 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 (Section 7),

4.1.4 Temper (Section 8),

4.1.5 Cross-sectional dimensions (outside diameter and wall thickness, or inside diameter and wall thickness for round tube; for tube other than round, square, rectangular, hexagonal, or octagonal with sharp corners, a drawing is required),

4.1.6 Length (straight or coiled),

4.1.7 Nominal inside diameter of coils and weight or maximum outside diameter, if applicable,

4.1.8 For alloy Alclad 3003 or Alclad 3102 state clad inside or outside (17.1).

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.
[6] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.
[7] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

TABLE 2 Tensile Property Limits[A,B]

Temper	Specified Wall Thickness,[C] in.	Tensile Strength, ksi		Yield Strength[D] (0.2 % offset), min, ksi	Elongation in 2 in. or 4 × Diameter,[E] min, %	
		min	max		Full-Section Specimen	Cut-Out Specimen
			Aluminum 1060[F]			
O	0.014–0.500	8.5	13.5	2.5	...	...
H12		10.0	...	4.0	...	...
H14		12.0	...	10.0	...	...
H18		16.0	...	13.0	...	...
H113[G]		8.5	...	2.5	...	...
			Aluminum 1100[F]			
O	0.010–0.500	11.0	15.5	3.5	...	...
H12		14.0	...	11.0	...	...
H14		16.0	...	14.0	...	...
H16		19.0	...	17.0	...	...
H18		22.0	...	20.0	...	...
H113[G]		11.0		3.5		
			Alloy 2011			
T3	0.018–0.049	47.0	...	40.0	...	...
	0.050–0.500	47.0	...	40.0	10	8
T4511	0.018–0.049	44.0	...	25.0	...	...
					...	...
	0.050–0.259	44.0	...	25.0	20	18
	0.260–0.500	44.0	...	25.0	20	20
T8	0.018–0.500	58.0	...	46.0	10	8
			Alloy 2014			
O	0.018–0.500	...	32.0	16.0 max	...	...
T4, T42[H]	0.018–0.024	54.0	...	30.0	10	...
	0.025–0.049	54.0	...	30.0	12	10
	0.050–0.259	54.0	...	30.0	14	10
	0.260–0.500	54.0	...	30.0	16	12
T6, T62[H]	0.018–0.024	65.0	...	55.0	7	...
	0.025–0.049	65.0	...	55.0	7	6
	0.050–0.259	65.0	...	55.0	8	7
	0.260–0.500	65.0	...	55.0	9	8
			Alloy 2024			
O	0.018–0.500	...	32.0	15.0 max	...	...
T3[H]	0.018–0.024	64.0	...	42.0	10	...
	0.025–0.049	64.0	...	42.0	12	10
	0.050–0.259	64.0	...	42.0	14	10
	0.260–0.500	64.0	...	42.0	16	12
T42[H]	0.018–0.024	64.0	...	40.0	10	...
	0.025–0.049	64.0	...	40.0	12	10
	0.050–0.259	64.0	...	40.0	14	10
	0.260–0.500	64.0	...	40.0	16	12
			Alloy 3003[F]			
O	0.010–0.024	14.0	19.0	5.0	...	...
	0.025–0.049	14.0	19.0	5.0	30	20
	0.050–0.259	14.0	19.0	5.0	35	25
	0.260–0.500	14.0	19.0	5.0	...	30
H12	0.010–0.500	17.0	...	12.0	...	...
H14	0.010–0.024	20.0	...	17.0	3	...
	0.025–0.049	20.0	...	17.0	5	3
	0.050–0.259	20.0	...	17.0	8	4
	0.260–0.500	20.0	...	17.0	...	...
H16	0.010–0.024	24.0	...	21.0	...	...
	0.025–0.049	24.0	...	21.0	3	2
	0.050–0.259	24.0	...	21.0	5	4
	0.260–0.500	24.0	...	21.0	...	...
H18	0.010–0.024	27.0	...	24.0	2	...
	0.025–0.049	27.0	...	24.0	3	2
	0.050–0.259	27.0	...	24.0	5	3
	0.260–0.500	27.0	...	24.0	...	...
H113[G]	0.010–0.500	14.0	...	5.0	...	...
			Alloy Alclad 3003			
O	0.010–0.024	13.0	19.0	4.5	...	...
	0.025–0.049	13.0	19.0	4.5	30	20
	0.050–0.259	13.0	19.0	4.5	35	25

TABLE 2 *Continued*

Temper	Specified Wall Thickness,[C] in.	Tensile Strength, ksi min	Tensile Strength, ksi max	Yield Strength[D] (0.2 % offset), min, ksi	Elongation in 2 in. or 4 × Diameter,[E] min, % Full-Section Specimen	Elongation in 2 in. or 4 × Diameter,[E] min, % Cut-Out Specimen
	0.260–0.500	13.0	19.0	4.5	...	30
H14	0.010–0.024	19.0	...	16.0	...	...
	0.025–0.049	19.0	...	16.0	5	...
	0.050–0.259	19.0	...	16.0	8	4
	0.260–0.500	19.0	...	16.0	...	...
H18	0.010–0.500	26.0	...	23.0	...	...
H113[G]	0.010–0.500	13.0	...	4.5	...	...
			Alloy 3102[F]			
O	0.018–0.049	12.0	17.0	4.0	30[I]	20[I]
	0.050–0.065	12.0	17.0	4.0	35	25
			Alloy Alclad 3102[F]			
O	0.018–0.049	10.0	17.0	3.5	30[I]	20[I]
						25
	0.050–0.065	10.0	17.0	3.5	35	
			Alloy 5005[F]			
O[F]	0.018–0.500	15.0	21.0	5.0	...	...
			Alloy 5050[F]			
O[F]	0.010–0.500	18.0	24.0	6.0	...	...
H32		22.0	...	16.0	...	...
H34		25.0	...	20.0	...	...
H36		27.0	...	22.0	...	...
H38		29.0	...	24.0	...	...
			Alloy 5052[F]			
O[F]	0.010–0.450	25.0	35.0	10.0	...	...
H32		31.0	...	23.0	...	...
H34		34.0	...	26.0	...	...
H36		37.0	...	29.0	...	...
H38		39.0	...	24.0	...	...
			Alloy 5083[F]			
O[F]	0.018–0.450	39.0	51.0	16.0	...	14
			Alloy 5086[F]			
O[F]	0.010–0.450	35.0	46.0	14.0	...	...
H32		40.0	...	28.0	...	...
H34		44.0	...	34.0	...	...
H36		47.0	...	38.0	...	...
			Alloy 5154[F]			
O	0.010–0.500	30.0	41.0	11.0	10	10
H34		39.0	...	29.0	5	5
H38	0.010–0.250	45.0	...	34.0	...	...
			Alloy 5456[F]			
O	0.018–0.450	41.0	53.0	19.0	...	14
			Alloy 6061			
O	0.018–0.500	...	22.0	14.0 max	15	15
T4	0.025–0.049	30.0	...	16.0	16	14
	0.050–0.259					
	0.260–0.500	30.0	...	16.0	18	16
		30.0	...	16.0	20	18
T42[H]	0.025–0.049	30.0	...	14.0	16	14
	0.050–0.259	30.0	...	14.0	18	16
	0.260–0.500	30.0	...	14.0	20	18
T6, T62[H]	0.025–0.049	42.0	...	35.0	10	8
	0.050–0.259	42.0	...	35.0	12	10
	0.260–0.500	42.0	...	35.0	14	12
			Alloy 6063			
O	0.018–0.500	...	19.0	...	...	...
T4, T42[H]	0.025–0.049	22.0	...	10.0	16	14
	0.050–0.259	22.0	...	10.0	18	16
	0.260–0.500	22.0	...	10.0	20	18

TABLE 2 *Continued*

Temper	Specified Wall Thickness,^{C} in.	Tensile Strength, ksi		Yield Strength^{D} (0.2 % offset), min, ksi	Elongation in 2 in. or 4 × Diameter,^{E} min, %	
		min	max		Full-Section Specimen	Cut-Out Specimen
T6, T62^{H}	0.025–0.049	33.0	...	28.0	12	8
	0.050–0.259	33.0	...	28.0	14	10
	0.260–0.500	33.0	...	28.0	16	12
T83	0.025–0.259	33.0	...	30.0	5	...
T831	0.025–0.259	28.0	...	25.0	5	...
T832	0.025–0.049	41.0	...	36.0	8	5
	0.050–0.259	40.0	...	35.0	8	5
			Alloy 6262			
T6, T62^{H}	0.025–0.049	42.0	...	35.0	10	8
	0.050–0.259	42.0	...	35.0	12	10
	0.260–0.500	42.0	...	35.0	14	12
T9	0.025–0.375	48.0	...	44.0	5	4
			Alloy 7075			
O	0.025–0.049	...	40.0	21.0 max	10	8
	0.050–0.500	...	40.0	21.0 max	12	10
T6, T62^{H}	0.025–0.259	77.0	...	66.0	8	7
	0.260–0.500	77.0	...	66.0	9	8
T73^{J}	0.025–0.259	66.0	...	56.0	10	8
	0.260–0.500	66.0	...	56.0	12	10

^{A} See Annex A1.
^{B} To determine conformance to this specification, each value for tensile strength and for yield strength shall be rounded 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.
^{C} Coiled tube is generally available with a maximum wall thickness of 0.083 in. and only in nonheat-treatable alloys.
^{D} Yield strength to be determined only on straight tube.
^{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} In this alloy tube other than round is produced only in the F (as drawn) and O tempers. Properties for F temper are not specified or guaranteed.
^{G} Beginning with the 1982 issue the requirements for the H112 tempers were replaced by the H113 temper, applicable to other than round tube, which is fabricated by cold-forming annealed round tube and acquires some temper in this forming operation.
^{H} Material in the T42 or T62 tempers is not available from the material producers.
^{I} For specified wall thickness under 0.025 in., elongation is not required.
^{J} Material in this temper exhibits improved resistance to stress corrosion compared to that of the T6 temper. The stress-corrosion resistance capability of individual lots is determined by testing the previously selected tension-test samples in accordance with the applicable electrical conductivity acceptance criteria of Table 3.

TABLE 3 Lot Acceptance Criteria for Resistance to Stress-Corrosion

Alloy and Temper	Lot Acceptance Criteria		Lot Acceptance Status
	Electrical Conductivity,^{A,B} % IACS	Level of Mechanical Properties	
7075–T73	40.0 or greater	per specified requirements	acceptable
	38.0 through 39.9	per specified requirements and yield strength does not exceed minimum by more than 11.9 ksi	acceptable
	38.0 through 39.9	per specified requirements but yield strength exceeds minimum by 12.0 ksi or more	unacceptable^{C}
	less than 38.0	any level	unacceptable^{C}

^{A} The electrical conductivity shall be determined in accordance with Practice E1004 in the following locations:

Wall Thickness, in.	Location
Up through 0.100	surface of tensile sample
0.101 and over	subsurface after removal of approximately 10 % of thickness.

^{B} For curved surfaces, the conductivity shall be measured on a machined flat spot; however, for small size tubes, a cut-out piece may be flattened and the conductivity determined.
^{C} When material is found to be unacceptable, it shall be reprocessed (additional precipitation heat treatment or resolution heat treatment and precipitation heat treatment).

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

4.2.1 Whether heat treatment in accordance with Practice B918 is required (11.2),

4.2.2 Whether flattening tests are required (Section 9 and Table 4),

4.2.3 Whether flare testing is required (Section 10),

4.2.4 Whether 7075-O material is required to develop requirements for T73 temper (12.3),

TABLE 4 Minimum Outside Diameter Flattening Factor

Alloy	Temper	Wall Thickness, in.	Minimum Diameter Flattening Factor, *F*
1100	O	0.014–0.500	2
	H12	0.014–0.500	3
	H14	0.014–0.500	6
	H16	0.014–0.500	8
3003	O	0.025–0.500	2
	H12	0.025–0.500	3
	H14	0.025–0.500	6
	H16	0.025–0.500	8
2024	O	0.018–0.049	3
		0.050–0.500	4
	T3	0.018–0.500	8
5052	O	0.010–0.450	3
	H32	0.010–0.450	6
	H34	0.010–0.450	8
5086	O	0.010–0.450	3
	H32	0.010–0.450	8
6061	O	0.018–0.120	3
		0.121–0.238	4
		0.239–0.500	6
	T4	0.025–0.500	6
	T6	0.025–0.500	8
7075	O	0.025–0.049	4
		0.050–0.259	5
	T6	0.025–0.259	10

4.2.5 Whether testing for leaks is required and, when leaks are allowed, the number of leaks allowed and the manner of marking leaks (15.1.3.2),

4.2.6 Whether inside cleanness test is required on coiled tubes (16.2) and frequency of testing required,

4.2.7 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 20),

4.2.8 Whether certification is required (Section 22),

4.2.9 Whether marking for identification is required (Section 23), and

4.2.10 Whether Practices B660 applies, and if so, the levels of preservation, packaging, and packing required (Section 24).

5. Materials and Manufacture

5.1 The tube shall be produced by drawing an extruded tube made from hollow extrusion ingot (cast in hollow form or pierced) and extruded by the use of the die and mandrel method.

5.2 The ends of coiled tube shall be crimped or otherwise sealed to avoid contamination during shipment.

6. Responsibility for Quality Assurance

6.1 *Responsibility for Inspection and Tests*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser in the order or at the time of signing the contract. 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.

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

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

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

7. Chemical Composition

7.1 *Limits*—The tubes shall conform to the chemical composition limits prescribed in Table 1. Conformance shall be determined by the producer by analyzing samples taken at the time the ingots are poured, or samples taken from the finished or semi-finished product. If the producer has determined the chemical composition of the material during the course of manufacture, he shall not be required to sample and analyze the finished product.

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

7.2.2 When samples are taken from the finished or semi-finished product, a sample shall be taken to represent each 4000 lb or fraction thereof of material in the shipment, except that no 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 from the material by drilling, sawing, milling, turning, or clipping a representative piece or pieces to obtain a prepared sample not less than 75 g. Sampling shall be in accordance with Practice E55.

7.3.2 Sampling for spectrochemical analysis shall be in accordance with Practice E716. 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