Designation: B 234M – 02

METRIC

Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes for Condensers and Heat Exchangers [Metric][1]

This standard is issued under the fixed designation B 234M; 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 covers aluminum-alloy (Note 1) drawn seamless round tube in straight lengths designated as shown in the Table 1, for use in surface condensers, evaporators, and heat exchangers.

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

NOTE 2—For drawn seamless tubes used in general applications, see Specification B 210M; for extruded tubes see Specification B 221M; for seamless pipe see Specification B 241/B 241M; and for structural pipe and tube see Specification B 429.

NOTE 3—This specification is the metric counterpart of Specification B 234.

1.2 Alloy and temper designations are in accordance with ANSI H35.1M. The equivalent Unified Numbering System alloy designations are those of Table 2 preceded by , for example, A91060 for aluminum 1060, in accordance with Practice E 527.

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

2. Referenced Documents

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

2.2 *ASTM Standards:*

B 210M Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes [Metric][2]

B 221M Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes [Metric][2]

B 241/B 241M Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube[2]

B 429 Specification for Aluminum-Alloy Extruded Structural Pipe and Tube[2]

B 557M Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products [Metric][2]

B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products[2]

B 666M Practice for Identification Marking of Aluminum and Magnesium Products [Metric][2]

B 918 Practice for Heat Treatment of Wrought Aluminum Alloys[2]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specification[3]

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys[4]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[4]

E 215 Practice for Standardizing Equipment for Electromagnetic Examination of Seamless Aluminum-Alloy Tube[5]

E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique[4]

E 527 Practice for Numbering Metals and Alloys (UNS)[6]

E 607 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere[4]

E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis[4]

E 1251 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Argon Atmosphere, Point-to-Plane, Unipolar Self-Initiating Capacitor Discharge[4]

2.3 *ANSI Standards:*

H35.1(M) Alloy and Temper Designation Systems for Aluminum[2]

H35.2(M) Dimensional Tolerances for Aluminum Mill Products[2]

2.4 *Federal Standard:*

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

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

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

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

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

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

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TABLE 1 Tensile Property Limits[A,B]

Alloy	Temper	Wall Thickness, mm		Tensile Strength, min, MPa	Yield Strength, (0.2 % offset), min, MPa	Elongation in 50 mm min, %	
		Over	Through			Full-Section Specimen	Cut-Out Specimen
1060	H14	0.25	5.00	85	70	...	...
3003	H14	0.25	0.63	140	115	3	...
		0.63	1.20	140	115	5	3
		1.20	5.00	140	115	8	4
	H25	0.25	5.00	150	130	...	...
Alclad 3003	H14	0.25	0.63	135	110	...	...
		0.63	1.20	135	110	5	3
		1.20	5.00	135	110	8	4
	H25	0.25	5.00	145	125	...	...
5052	H32	0.25	5.00	215	160	...	...
	H34	0.25	5.00	235	180	...	...
5454	H32	0.25	1.20	250	180	...	5
		1.20	5.00	250	180	...	8
	H34	0.25	1.20	270	200	...	4
		1.20	5.00	270	200	...	6
6061	T4	0.25	1.20	205	110	16	14
		1.20	5.00	205	110	18	16
	T6	0.25	1.20	290	240	10	8
		1.20	5.00	290	240	12	10

[A] To determine conformance to this specification, each value for tensile strength and for yield strength shall be rounded to the nearest 1 MPa and each value for elongation to the nearest 0.5 %, both in accordance with the rounding-off method of Practice E 29.
[B] The basis for establishment of mechanical property limits is shown in Annex A1.

TABLE 2 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[G]
3003	0.6	0.7	0.05–0.20	1.0–1.5	...	...	0.10	...	0.05	0.15	remainder
Alclad 3003	3003 alloy clad with 7072 alloy										
5052	0.25	0.40	0.10	0.10	2.2–2.8	0.15–0.35	0.10	...	0.05	0.15	remainder
5454	0.25	0.40	0.10	0.50–1.0	2.4–3.0	0.05–0.20	0.25	0.20	0.05	0.15	remainder
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
7072[H]	0.07 Si + Fe		0.10	0.10	0.10	...	0.8–1.3	...	0.05	0.15	remainder

[A] Limits are in 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 attained 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 E 29.
[D] *Others* includes listed elements for which no specific limit is shown as well as unlisted metallic elements. The producer may analyze samples for trace elements not specified in this specification. However, such analysis is not required and may not cover all metallic *Others* elements. Should any analysis by the producer or the purchaser establish that an *Others* element exceeds the limit of *Each* or that the aggregate of several *Others* elements exceeds the limit of *Total*, the material shall be considered nonconforming.
[E] *Other Elements—Total* shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.
[F] Vanadium 0.05 max.
[G] The aluminum content shall be calculated by subtracting from 100.00 % the sum of all the metallic elements present in amounts of 0.010 % or more, rounded to the second decimal before determining the sum.
[H] Composition of cladding alloy as applied during the course of manufacture. The sample from finished tube shall not be required to conform to these limits.

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[7]

2.5 *Military Standard:*

MIL-STD-129 Marking for Shipment and Storage[7]

2.6 *AMS Specification:*

AMS 2772 Heat Treatment of Aluminum Alloy Raw Materials[8]

3. Terminology

3.1 *Definitions:*

3.1.1 *tube*—a hollow wrought product that is long in relation to its cross section, which is round, a regular hexagon, a regular octagon, elliptical, or square or rectangular with sharp or rounded corners, and that has uniform wall thickness except as may be affected by corner radii.

3.1.2 *drawn seamless tube*—a tube produced from hollow ingot and brought to final dimensions by drawing through a die.

[7] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.
[8] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

3.1.3 *alclad tube*—a tube having on either the inside or the outside surface a metallurgically bonded aluminum alloy coating that is anodic to the core alloy to which it is bonded, thus electrolytically protecting the core alloy against corrosion.

3.1.4 *heat exchange tube*—a tube for use in apparatus in which fluid inside the tube will be heated or cooled by fluid outside the tube. The term usually is not applied to coiled tube or to tube for use in refrigerators or radiators.

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

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *capable of*—the term *capable of* as used in this specification means that the test need not be performed by the producer of the material. However, should testing by the purchaser establish that the material does not meet these requirements, the material shall be subject to rejection.

4. Ordering Information

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

4.1.1 The specification designation (which includes the number, the year, and the revision letter, if applicable),

4.1.2 Quantity in pieces or kilograms,

4.1.3 Alloy (Section 7),

4.1.4 Temper (Section 8),

4.1.5 Outside or inside diameter, wall thickness, and length,

4.1.6 For alloy Alclad 3003, state clad inside or outside (12.1).

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 B 918 is required (9.2),

4.2.2 Whether cut ends of tube are to be deburred (Section 14),

4.2.3 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 15),

4.2.4 Whether certification of the material is required (Section 17),

4.2.5 Whether marking for identification is required (Section 18), and

4.2.6 Whether Practices B 660 applies and, if so, the level of preservation, packaging, and packing required (19.3).

5. 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 use of the die and mandrel method.

6. Responsibility for Quality Assurance

6.1 *Responsibility for Inspection and Tests*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser in the order or at the time of contract signing. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to assure that material conforms to prescribed requirements.

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

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

7. Chemical Composition

7.1 *Limits*—The tube shall conform to the chemical composition limits in Table 2. 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 4—It is standard practice in the United States aluminum industry to determine conformance to the chemical composition limits prior to further processing of ingots into wrought products. Due to the continuous nature of the process, it is not practical to keep a specific ingot analysis identified with a specific quantity of finished material.

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 2000 kg or fraction thereof of material in the lot, except that not more than one sample shall be required per piece.

7.3 *Methods of Sampling*—Samples for determination of chemical composition shall be taken in accordance with one of the following methods:

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

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

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

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

8. Tensile Properties of Material as Supplied

8.1 *Limits*—The tube shall conform to the tensile property requirements in Table 1.

8.2 *Number of Specimens*:

8.2.1 For material having a nominal mass up through 1.7 kg/linear m, one tension test specimen shall be taken for each 500 kg, or fraction thereof in the lot.

8.2.2 For material having a nominal mass over 1.7 kg/linear m, one tension test specimen shall be taken for each 300 m or fraction thereof in the lot.

8.2.3 Other procedures for selecting samples may be employed if agreed upon by the producer and the purchaser.

8.3 *Test Methods*—The tension tests shall be made in accordance with Test Methods B 557M.

9. Heat Treatment

9.1 Unless otherwise specified in 9.2, producer or supplier heat treatment for the applicable tempers in Table 1 shall be in accordance with AMS 2772.

9.2 When specified, heat treatment of applicable tempers in Table 1 shall be in accordance with Practice B 918.

10. Leak Test

10.1 Each length of tube less than 40 mm in diameter shall be tested by either of the following methods, at the option of the producer or supplier, consistent with the size limitations indicated:

10.1.1 *Method 1*—Applicable to tube with a wall thickness of 5.00 mm max. Each tube shall be subjected to an internal air gage pressure of 1700 kPa for 5 s while immersed in a suitable liquid. Any evidence of leakage shall be cause for rejection.

10.1.2 *Method 2*—Applicable to tube with a wall thickness of 2.00 mm max, as covered by Practice E 215. Each tube shall be subjected to an eddy-current test in accordance with the procedures described in Practice E 215. Reference standards described in Appendixes X1 and X2 of Practice E 215 shall be used to standardize the equipment. These same reference standards or secondary standards having equivalent eddy current response shall also serve to define acceptance-rejection limits. Tubes that produce eddy current indications less than those from the 2*A* holes of the applicable reference standard or an equivalent secondary standard shall be acceptable. Any tube having a discontinuity that produces an eddy current indication equal to or greater than those from the 2*A* holes of the applicable reference standard or an equivalent secondary standard shall be rejected.

11. Expansion Test

11.1 The tube ends shall be capable of being flared, without showing cracks or ruptures visible to the unaided eye when corrected for normal vision, by forcing a steel pin having a taper of 125 mm/m into the tube until the inside diameter has been increased 20 %.

12. Cladding

12.1 The aluminum alloy cladding of Alclad 3003 tube shall, as specified, comprise either the inside surface (only) and its thickness shall be approximately 10 % of the total wall thickness, or the outside surface (only) in which case its thickness shall be approximately 7 % of the total wall thickness.

12.2 When the thickness of the cladding is to be determined on finished tube, transverse cross sections of at least three tubes from the lot shall be polished for examination with a metallurgical microscope. Using a magnification of 100×, the cladding thickness at four points, 90° apart, in each sample shall be measured and the average of all measurements shall be taken as the thickness. In the case of tubes having a diameter larger than can properly be mounted for polishing and examination, the portions of the cross section polished for examination may consist of an arc about 12 mm in length.

13. Dimensional Tolerances

13.1 Variations from the specified wall thickness, length, outside diameter, straightness, and squareness of cut ends shall not exceed the tolerances specified in the tables of ANSI H35.2(M) (See Table 3).

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

14. General Quality

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

14.2 Grinding to remove minor surface imperfections shall not be cause for rejection, provided the repaired area is within dimensional tolerances.

14.3 When so specified on the purchase order, the cut ends of each tube shall be deburred by the use of a wire wheel, file or other suitable tool or device.

14.4 Each 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.

TABLE 3 Tables of ANSI H35.2 (M)

Table No.	Title
14.1	Wall Thickness
14.2	Length
14.3	Outside Diameter, Heat-Treatable Tube
14.4	Outside Diameter, Non-Heat-Treatable Tube
14.5	Straightness
14.6	Squareness of Cut Ends

15. Source Inspection

15.1 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.

15.2 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.

16. Retest and Rejection

16.1 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.

16.2 When there is evidence that a failed specimen was not representative of the inspection lot and when no other sampling plan is provided or approved by the purchaser through the contract or purchase order, at least two additional specimens shall be selected to replace each test specimen that failed. All specimens so selected for re-test shall meet the requirements of the specification or the lot shall be subject to rejection.

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

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

17. Certification

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

18. Identification Marking of Product

18.1 When specified in the contract or purchase order all material shall be marked in accordance with Practice B 666M.

18.2 The foregoing requirements are minimum; marking systems which involve added information, large characters, and greater frequencies are acceptable under this specification.

19. Packaging and Package Marking

19.1 The material shall be packaged to provide adequate protection during normal handling and transportation, and each package shall contain only one alloy, temper, and size of material unless otherwise agreed. The type of packaging and gross mass of containers shall, unless otherwise agreed upon, be at the producer's or supplier's discretion, provided that they are such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the delivery point.

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

19.3 When specified in the contract or purchase order, material shall be preserved, packaged, and packed in accordance with the requirements of Practices B 660. 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 the MIL-STD-129 for Military agencies.

20. Keywords

20.1 aluminum alloy; drawn seamless tubes; heat exchangers

ANNEXES

(Mandatory Information)

A1. BASIS FOR INCLUSION OF PROPERTY LIMITS

A1.1 Limits are established at a level at which a statistical evaluation of the data indicates that 99 % of the population obtained from all standard material meets the limit with 95 % confidence. For the products described, mechanical property limits for the respective size ranges are based on the analyses of at least 100 data from standard production material with no more than ten data from a given lot. All tests are performed in accordance with the appropriate ASTM test methods. For informational purposes, refer to "Statistical Aspects of Mechanical Property Assurance" in the Related Material section of the *Annual Book of ASTM Standards*, Vol 02.02. Mechanical property limits in this metric issue were derived from the inch-pound system limits that were developed under the above principles. As test data on metric dimensioned specimens are accumulated, some refinement of limits, particularly for elongations measured in 5D, can be anticipated.

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(M). The Aluminum Association[9] 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(M). A designation not in conflict with other designation systems or a trade name is acceptable.

A2.2.2 The aluminum or aluminum alloy has been offered for sale in commercial quantities within the prior twelve months to at least three identifiable users.

A2.2.3 The complete chemical composition limits are submitted.

A2.2.4 The composition is, in the judgment of the responsible subcommittee, significantly different from that of any other aluminum or aluminum alloy already in this specification.

[9] The Aluminum Association, 900 19th Street, NW, Washington, DC 20006.

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 0.10 through 0.55 %	0.0X 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 (Note A2.1); Titanium; 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 zinc and titanium, or are specified in footnotes.

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

APPENDIX

(Nonmandatory Information)

X1. GENERAL INFORMATION

X1.1 The following information does not constitute a part of this specification but is intended to assist in the proper selection and use of the materials.

X1.2 Alloys 1060, 3003, alclad 3003, 5052, and 5454 are supplied in a strain-hardened temper to meet the specified tensile and yield strengths. Alloy 6061 is supplied in the heat-treated temper (-T4) and in the heat-treated and aged temper (-T6); the -T4 temper is more workable, and after forming work is completed may be aged to the stronger -T6 temper. A typical aging treatment would be to hold the material at 170°C for 6 to 10 h in a suitable furnace and allow to cool at room temperature.

X1.3 Aluminum heat-exchanger tubes are resistant to most petroleum products and a large number of organic and inorganic chemicals. Aluminum is very resistant to hydrogen sulfide and carbon dioxide. Alloy alclad 3003 tubes are generally recommended in those heat-exchanger services where salt or fresh cooling waters within a pH range of 5 to 8 pass through the tubes. Waters with a pH outside of this range may or may not be corrosive, depending on what compounds present in the water contribute to the acidity or alkalinity.

SUMMARY OF CHANGES

This section identifies the principal changes to this standard that have been incorporated since the last issue.

(*1*) Replaced Practice B 597 with Practice B 918 in 2.2, 4.2.1, and 9.2.
(*2*)Replaced MIL-H-6088 with AMS 2772 in 2.6 and 9.1.
(*3*)Added B 210M, B 221M, B 241/B 241M, and B 429 to Referenced Documents.

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