

Tempers For Aluminum & Aluminum Alloy Products Metric Edition



1400 Crystal Drive, Suite 430
Arlington, VA 22202
www.aluminum.org

Revised: **May 2018**

Supersedes: **July 2011**

© Copyright 2018, The Aluminum Association, Inc.
Unauthorized reproduction and sale by photocopy or any other method is illegal.

Use of the Information

The Aluminum Association has used its best efforts in compiling the information contained in this publication. Although the Association believes that its compilation procedures are reliable, it does not warrant, either expressly or impliedly, the accuracy or completeness of this information. The Aluminum Association assumes no responsibility or liability for the use of the information herein.

Please check www.aluminum.org for postings of errata.

All Aluminum Association published standards, data, specifications and other material are reviewed at least every five years and revised, reaffirmed or withdrawn. Users are advised to contact The Aluminum Association to ascertain whether the information in this publication has been superseded in the interim between publication and proposed use.

CONTENTS

FOREWORD.....	i
TEMPER REGISTRATION.....	ii
Procedure for Individual Registration of Tempers	ii
Procedures for Aluminum Association Technical Division (AATD) Registration of Tempers	v
Requirements for Proposed Changes to Registered Tempers	v
Requirements for Deletion of Tempers from the Registered List	v
REGISTERED TEMPERS - WROUGHT PRODUCTS	1
REGISTERED TEMPERS - CAST PRODUCTS.....	45
FOOTNOTES	46
INACTIVE ALLOYS AND TEMPERS.....	48
APPENDIX A: GUIDELINES FOR TRANSITIONING U.S. CUSTOMARY UNITS TO METRIC (SI) UNITS.....	58

FOREWORD

Listed in this booklet, in Metric (SI) units only, are the tempers for aluminum and aluminum alloy products registered with The Aluminum Association but not contained in The Association's Aluminum Standards and Data Metric SI.

For most of this publication, the method of preparation has been to arrive at logical metric values rather than to restate current U.S. Customary values in metric terms by use of conversion factors. The metric units in this publication are based on the International System of Units (SI). The strength properties are expressed in megapascals (MPa). Refer to APPENDIX A, "Guidelines for Transitioning U.S. Customary units to Metric (SI) Units", for specific conversion procedures and to the Yellow Sheets (Tempers for Aluminum and Aluminum Alloy Products) for registered tempers with limits shown in U.S. Customary units.

Some of the registered tempers may be the subject of U.S. patents or patent applications, and their listing herein is not to be construed in any way as the granting of a license under such patent rights.

Tempers for wrought products are given on pages 1-45 and for castings on page 46. Inactive alloys and tempers are listed on pages 49-57.

An explanation for The Aluminum Association's "Temper Designation System" is given in the Aluminum Standards and Data—Metric SI and in the American National Standard ANSI H35.1/H35.1(M).

All new tempers registered since the previous issue as well as revisions to the prior registrations are marked and defined. In addition, the registration column also includes a revision date to denote the latest revision to the registered information.

TEMPER REGISTRATION

When any aluminum or aluminum alloy material is produced in a temper not previously applied to that material, the temper, along with the alloy designation and product form to which it applies, may be registered with The Aluminum Association.

PROCEDURE FOR INDIVIDUAL REGISTRATION OF TEMPER

1. Any person, firm or corporation may apply to The Aluminum Association to register a new temper.
2. Selection of the temper designation usually is left to the discretion of the Technical Committee on Product Standards, but consideration will be given to the applicant's choice when circumstances so warrant.
3. The temper is registered when, in the opinion of the Technical Committee on Product Standards, it is judged to be technically correct and complete with respect to the following:
 - 3.a. The temper designation conforms to ANSI H35.1(M) "Alloy and Temper Designation Systems for Aluminum" (reprinted in The Aluminum Association manual Aluminum Standards and Data – Metric SI).
 - 3.b. The material is offered for sale in the proposed temper and is available for use by more than one user.
 - 3.c. The mechanical property limits applicable to the temper are included. (Limits are shown as tentative unless established in accordance with the data base criteria outlined under "Mechanical Properties" in Section 6, "Standards Section" of Aluminum Standards and Data – Metric SI).
 - 3.c.1. The following procedure describes a method to register 6xxx and some 7xxx in -T3, -T4, -T6, -T7, -T8 and -T9 Tempers, when the temper being registered is normally produced using extrusion press solution heat treatment, rolling mill solution heat treatment or forging press solution heat treatment.
 - 3.c.1.1. Collect 100 samples minimum from at least 5 different cast lots and 10 different heat treat lots of extrusion press solution heat treated, rolling mill solution heat treated or forging press solution heat treated material. No more than 10 tests from a given heat treat lot shall be included in the data analysis. Stretch, cold work, straighten or otherwise finish the material as described in Aluminum Standards and Data – Metric SI Section 1, Alloy and Temper Designation System for Aluminum (ANSI H35.1(M)), Paragraph 4.2.2, for the temper being registered. Then either naturally age (T3 and T4) or artificially age (T6, T7, T8, and T9) the material before sampling and tensile testing per ASTM B 557M. Statistically analyze the data for Ultimate Tensile Strength, Yield Strength, and Elongation, and report the minimum values for each at which at least 99 percent of the material is expected to conform at a confidence level of 0.95.
 - 3.c.1.1.1. The 100 tests shall include samples which span the thickness range(s) to be registered, including samples from the thinnest section or diameter, the thickest section or diameter and, if appropriate, intermediate sections or diameters. There shall be a minimum of 30 tests for each thickness range to be registered.
 - 3.c.1.2. Collect 30 samples minimum from at least 3 different cast lots of material extruded, rolled or forged and solution heat treated in a production or commercial furnace. Stretch, cold work, straighten or otherwise finish the material as described in Aluminum Standards and Data – Metric SI Section 1, Alloy and Temper Designation System for Aluminum (ANSI H35.1 (M)), Paragraph 4.2.2, for the temper being registered. Then either naturally age (T3 and T4) or artificially age (T6, T7, T8, and T9) the material before sampling and tensile testing per ASTM B 557M. Statistically analyze the data for Ultimate Tensile Strength, Yield Strength, and Elongation, and report the

TEMPER REGISTRATION (continued)

minimum values for each at which at least 99 percent of the material is expected to conform at a confidence level of 0.95.

3.c.1.2.1. The 30 tests may include samples from one or multiple gauge thickness.

3.c.1.3. The registering entity shall report all calculated minimum values to the Technical Committee on Product Standards, along with the minimum limits the registering entity wishes to register.

3.c.1.4. The Technical Committee on Product Standards will then review the temper based on the proposed minimum limits of the registering entity, provided the minimum limits are not larger than the minimum values calculated in steps 3.c.1.1. and 3.c.1.2. of this procedure.

3.c.1.5. Tempers registered using this procedure shall carry the following note in the Remarks column: "The registered properties for this material are calculated in accordance with the procedure described in Section 3.c.1.

3.c.2. Tentative Limit Registration

3.c.2.1. Tentative limits are temporary in nature and are established to allow the producer to manufacture and sell the product while continuing to collect data. Tentative temper designations shall be reviewed every 2 years for possible resolution of the tentative status.

3.c.2.2. The mechanical property limits defined as tentative are established at levels at which at least 99% of the data conform at a confidence level of 95%. The limited number of observations required for a tentative registration may not represent the property distribution that is expected due to random variation within the manufacturing practice and may not have a normal distribution.

3.c.2.3. For heat treatable alloys, tentative limits are based on the results of a minimum of 30 tests from at least 3 cast lots and at least 3 heat treat lots of material. For non heat treatable alloys, tentative limits are based on the results of a minimum of 30 tests from at least 3 cast lots of material that have separately passed through subsequent processing operations as at least 3 fabricated inspection lots.

3.c.2.4. For heat treatable and non heat treatable alloys, the 30 tests shall include observations from all gauge ranges. Multiple ranges can be proposed when there are at least 10 tests from each gauge range or by using regression analysis of the 30 tests.

3.c.2.5. Tentative limits for 6xxx and some 7xxx in -T3, -T4, -T6, -T7, -T8 and -T9 Tempers, when the temper being registered is normally produced using extrusion press solution heat treatment, rolling mill solution heat treatment or forging press solution heat treatment (see 3.c.1.), are based on the results of a minimum of 30 tests from at least 3 cast lots and at least 3 heat treat lots of material processed as described in 3.c.1.1. and a minimum of 30 tests from at least 3 cast lots and at least 3 heat treat lots of material processed as described in 3.c.1.2.

3.c.2.5.1. The 30 tests from the material processed as described in 3.c.1.1. shall include samples which span the thickness range(s) to be registered, including samples from the thinnest section or diameter, the thickest section or diameter and, if appropriate, intermediate sections or diameters. There shall be a minimum of 10 tests for each thickness range to be registered.

3.c.2.5.2. The 30 tests from material processed as described in 3.c.1.2. may be from one or multiple gauge thickness.

TEMPER REGISTRATION (continued)

- 3.d. The following additional information is included when characteristics, in addition to mechanical properties, are specified for the temper:
 - 3.d.1. Test methods by which conformance with the requirements for specified characteristics can be evaluated, OR
 - 3.d.2. Details of the practice to be followed in producing the temper.
- 3.e. When not already registered, the minimum tensile strength limit applicable to the O temper shall accompany the request for registration of H tempers.
 - 3.e.1. If the annealed product is not offered for sale and the O temper limits that accompany an H temper registration are based on material annealed in standard production furnaces, the description provided in the Remarks column of the registration shall state "O temper not offered for sale but used as basis for H temper registration."
 - 3.e.2. If the annealed product is not offered for sale, the O temper limits can be measured on laboratory annealed materials. These limits shall be designated as O2 and the description provided in the Remarks column of the registration shall state "O temper not offered for sale. O2 temper used as basis for H temper registration."
 - 3.e.3. When the O temper or O2 temper limits are based on the requirements of a tentative registration, the O or O2 limits will be shown as tentative. However, O or O2 temper tentative limits, which are noted as not being offered for sale, shall not be subject to the two year review.
- 3.f. The indication of a variation in treatment of a basic T temper is limited to one additional digit (excluding zero) unless all available digits have been used, and except as provided for in the Appendix to ANSI H35.1(M).
- 3.g. A description of the process variation or the product characteristics of the registration shall be provided when an additional digit, beyond those defined, is requested.
- ± 4. When an expansion of the gauge range for an existing temper is registered, the following additional procedures apply:
 - 4.a. For registrations that are not tentative, registration of an expansion to the existing gauge range for the registered temper shall be treated as an independent registration in accordance with the procedures provided in section 3.
 - 4.b. When a tentative registration is being finalized by removing the tentative status, the gauge range can be expanded by adding to the data from the existing tentatively registered gauge range provided that the following 3 conditions apply:
 - 4.b.1. The data from the existing tentative registration is available for analysis, and
 - 4.b.2. The data for the gauge range to be added to the registration complies with 3.c.2.3. and 3.c.2.4. and 3.c.2.5, and
 - 4.b.3. The combined data set is sufficient to meet the criteria outlined under "Mechanical Properties" in Section 6, "Standards Section" of Aluminum Standards and Data-Metric SI and analysis of the combined data set supports the limits published for the gauge range of existing tentative registration.
 - 4.c. Alternatively, the gauge range of a registered tentative temper can be expanded by treating the expanded gauge range as an independent tentative registration in accordance with the procedures provided in section 3.c.2.

TEMPER REGISTRATION (concluded)

PROCEDURES FOR ALUMINUM ASSOCIATION TECHNICAL DIVISION (AATD) REGISTRATION OF TEMPERS

A temper for an aluminum alloy material may be registered as an AATD temper when, through formal ballot of the Technical Committee on Product Standards, all the following requirements are met:

1. The material is offered for sale in the proposed temper and gauges(s) by more than one producer.
2. The material meets all the requirements listed in the *Procedure for Individual Registration of Tempers* section of this document.
3. The temper is not registered with a tentative status.

REQUIREMENTS FOR PROPOSED CHANGES TO REGISTERED TEMPERS

Proposed changes to a registered designation's mechanical properties and/or characteristics:

1. Require approval by formal ballot of the Technical Committee on Product Standards for registered tempers having "minimum" and/or "maximum" mechanical property limits.
2. Require a 30-day review by the Technical Committee on Product Standards for registered tempers having "tentative" mechanical property limits. The registrant has the final authority to change the temper limits, provided the change complies with item 3 under Individual Registration of Tempers. Changes proposed by others than the registrant are acceptable only with the approval of the registrant.

REQUIREMENTS FOR DELETION OF TEMPERS FROM THE REGISTRATION LIST

1. When any alloy is removed from the active alloy registration list, all tempers applicable to that alloy are automatically removed from the active temper registration list.
2. Approval of the Technical Committee on Product Standards through formal ballot is required to effect deletion of any registered temper from the active registration list, except as provided by the preceding sentence.

...

This page left intentionally
blank.

Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
1100-O2	Alumax	04/04/78	Fin Stock	0.13	0.30	Min Max	75 110	35 -	15 -	-	Minimum amount of cold work controlled. Temper controlled within especially close limits. Extra hard temper closely controlled.
1100-H151	Alcoa	-	Tube	-	-	Min	115	-	-	-	
1100-H181	Alcoa	-	Sheet	0.32	0.50	Min	145	140	1	-	
1100-H185	AATD	-	Impact	0.70	-	Min ⁶	150	140	-	-	
1100-H19	Alcoa	02/23/56	Wire	0.15	1.60	Min	165	-	-	-	
1100-H191	Alcoa	-	Sheet	0.32	0.50	Min	160	150	1	-	
1200-O	AATD	07/01/68	Sheet & Plate	0.15	80.00	Min Max	70 105	- -	* -	** -	*15% for over 0.15 thru 0.50 *20% for over 0.50 thru 0.80 *25% for over 0.80 thru 1.30 *30% for over 1.30 thru 6.30 *28% for over 6.30 thru 12.50 **25% for over 12.50 thru 80.00
1200-H112	AATD	07/01/68	Sheet, Plate & Extrusion	-	-	Min	70	-	25	22	
1200-H12	AATD	07/01/68	Sheet & Plate	0.40	50.00	Min Max	90 125	- -	* -	** -	
1200-H14	AATD	07/01/68	Sheet & Plate	0.20	25.00	Min Max	105 140	- -	* -	** -	
1200-H16	AATD	07/01/68	Sheet	0.15	4.10	Min Max	125 160	- -	* -	- -	
1200-H18	AATD	07/01/68	Sheet	0.15	3.25	Min	140	-	*	-	
1235-O	Alcoa	05/12/80	Drawn Tube (Straight)	0.32	12.50	Min Max	70 105	20 -	35 -	- -	
1235-O	Alcoa	05/12/80	Drawn Tube (Coiled)	0.32	1.60	Min Max	75 110	25 -	35 -	- -	
1235-H18	Alcoa	05/12/80	Drawn Tube	0.32	12.50	Min	125	110	3	-	
1235-H111	Alcoa	05/12/80	Drawn Tube	0.32	12.50	Min	75	50	30	-	

Footnotes appear beginning on page 46.



Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
1145-H12	AATD	11/06/67	Sheet	-	-	Min Max	75 110	- -	- -	- -	Fin Stock
1145-H16	AATD	11/06/67	Sheet	-	-	Min Max	110 145	- -	- -	- -	Fin Stock.
1145-H18	AATD	11/06/67	Sheet	-	-	Min	125	-	-	-	Fin Stock.
1345-H24	Reynolds	05/17/63	Wire	0.75	6.30	Min	95	-	-	-	
1345-H26	Reynolds	05/17/63	Wire	0.75	6.30	Min	110	-	-	-	
1350-H113	AATD	05/28/71	Wire	Up thru #1		Min Max	85 140	- -	- -	- -	Conforms to ICEA requirements for solid conductors. Applicable to insulated conductors and currently specified as "1/2 to 3/4 hard". Applicable to insulated conductors and currently specified as "3/4 to full hard".
				1/0 and over		Min Max	60 140	- -	- -	- -	
1350-H141	Alcoa	06/20/69	Wire	-	10.00	Min	105	-	-	-	
1350-H142	Alcoa	09/09/69	Wire	-	10.00	Min Max	105 150	- -	- -	- -	
1350-H161	Alcoa	09/09/69	Wire	-	10.00	Min	115	-	-	-	
2008-T4	Alcoa	10/20/87 Revised 03/09/95	Sheet	0.63	1.90	Min	220	105	22	-	
2010-T4	Reynolds	06/16/94 Revised 10/29/98	Sheet	0.63	1.80	Min	220	110	22	-	The material shall exhibit (1) No lines or ridges in the rolling direction after buffing or polishing a blank, typically 50 mm by 230 mm, oriented with the long axis in the long transverse direction and stretching 5%, or (2) Random distribution of grain orientations with no continuous bands of cube oriented grains as determined by microtexture analysis of the rolling surface of the sheet using orientation image microscopy (OIM).
2010-T41	Reynolds	12/19/95 Revised 10/29/98	Sheet	0.63	1.80	Min	220	110	22	-	
2011 -T6 & -T651	Kaiser	11/01/93	Rod	10.00	160.00	Min	370	275	10	9	Cold finished rod.
+ 2111-T8	Kaiser	01/18/18	Rod & Bar	12.70	88.90	*Min ⁶	360	260	-	9	*Tentative Cold finished Rod & Bar used primarily in, but not limited to, machining applications
+ 2013-T4511	Sumitomo	08/01/12	Drawn Tube	3.00	10.00	*Min ⁶	275	145	20	-	*Tentative
	Sumitomo	09/19/03	Extrusion	-	5.00	Min ⁶	400	365	8	-	<u>Exfoliation Corrosion Resistance</u> See footnote 15.b.
+ 2013-T6511	Sumitomo	12/15/11	Drawn Tube	3.00	10.00	*Min ⁶	415	385	7	-	*Tentative

Footnotes appear beginning on page 46.

Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
2014-T41	Alcoa	-	Die Forging	-	-	Min	360	185	12	11	Quenched from solution temperature to provide minimum internal stress. Because the T41 temper has lowered resistance to corrosion, it should be used only for forgings which are to be artificially aged to the T61 temper before use.
2014-T61	Alcoa	-	Die Forging	-	50.00	Min ³	395	310	6	5	To provide low level of internal stress. Artificially aged from T41.
2014-T611	Alcoa	04/15/68	Die Forging	-	50.00	Min ³	430	365	6	5	To provide low level of internal stress with mechanical properties between those of the T6 and T61 tempers.
2014-T64	Alcoa	-	Extrusion	-	-	Min	405	360	7	6	For stock with lower residual stresses.
2017 -H15 & -H25	Alcoa	09/12/89	Wire & Rod	-	25.00	Min Max	240 310	- -	- -	- -	For rivet and cold heading wire.
2219-T31	Alcoa	06/30/60	Drawn Tube	-	12.50	Min	310	180	12	-	Solution heat treated and cold worked a specific controlled amount.
2219-T7	Alcoa	01/10/80	Forged Piston	-	80.00	Min ³ Min ⁸	380 365	220 205	8 4	7 3	Intended to give minimum growth and maximum stability. BHN 93 minimum.
2219-T851	Alcoa	05/28/86	Die Forging	-	50.00	Min ⁶ Min ⁹	430 415	345 315	6 3	5 2	
2519-T87	Alcoa	03/14/86	Armor Plate	12.50 40.00 50.00 80.00	40.00 50.00 80.00 100.00	Min ⁶ Min ⁹ Min ⁶ Min ⁹ Min ⁶ Min ⁹ Min ⁶ Min ⁹	455 470 455 470 460 470 470 470	405 400 405 400 415 405 420 405	- - - - - - - -	9 6 8 6 7 5 6 4	Solution heat treated, cold worked approximately 8% and artificially aged.
2024-T3	Alcoa	05/22/85	Foil	0.040	0.063	Min	330	250	2	-	Limits (Customary) same as MIL-A-81596.
2024-T351	Kaiser	05/15/02	Rod	160.00	200.00	Min	425	310	-	8	Cold finished.
2024-T432	Alcan/ Airbus	11/12/04	Extrusion	1.60	10.00	Min ⁶	470	330	14	-	Peripheral coarse grain control. Absence of re-crystallization.
2024-T81	Alcoa	08/23/83	Drawn Tube	0.25 0.63 1.20	0.63 1.20 12.50	Min Min Min	455 455 455	400 400 400	- * *	- - -	*Full Section - 5% 6% *Cut Out - 4% 5%
2024-T81	Alcoa	05/22/85	Foil	0.040	0.063	Min	415	380	1	-	Limits (Customary) same as MIL-A-81596.
2024-T84	Alcoa	-	Tube	-	-	Min	485	450	3	-	Amount of cold work between solution heat treatment and artificial aging is controlled at about 4%.
2124-O	Reynolds	09/12/83	Sheet	1.20	5.00	Max	220	95	12 (Min)	-	
2124-T62	Reynolds	09/12/83	Sheet	1.20	5.00	Min	425	330	5	-	

Footnotes appear beginning on page 46.

Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
2124-T8151	Alcoa	10/06/86	Plate	25.00	40.00	Min ⁶ Min ⁹	470 470	430 430	- -	7 6	<u>Fracture Toughness</u> ¹⁴ – Min K _{IC} For thicknesses over 40.00 thru 50.00 mm L-T direction 29 MPa $\sqrt{m}$ T-L direction 25 MPa $\sqrt{m}$ S-L direction 21 MPa $\sqrt{m}$ For thicknesses over 50.00 thru 100.00 mm L-T direction 29 MPa $\sqrt{m}$ T-L direction 24 MPa $\sqrt{m}$ S-L direction 22 MPa $\sqrt{m}$ For thicknesses over 100.00 thru 160.00 mm L-T direction 27 MPa $\sqrt{m}$ T-L direction 23 MPa $\sqrt{m}$ S-L direction 23 MPa $\sqrt{m}$
				40.00	50.00	Min ⁶ Min ⁹ Min ¹⁰	470 470 450	430 430 395	- - -	7 6 2	
				50.00	80.00	Min ⁶ Min ⁹ Min ¹⁰	460 460 440	415 415 395	- - -	7 6 2	
				80.00	100.00	Min ⁶ Min ⁹ Min ¹⁰	460 460 440	405 405 395	- - -	6 5 2	
				100.00	120.00	Min ⁶ Min ⁹ Min ¹⁰	455 455 435	400 400 380	- - -	5 5 2	
				120.00	160.00	Min ⁶ Min ⁹ Min ¹⁰	450 450 430	395 385 370	- - -	5 4 2	
2224-T3510 & -T3511	Boeing	12/21/78	Extrusion	6.30	20.00	Min ⁶	450	330	12	10	Requires special extrusion practice; standard 2024 heat treatment.
				20.00	40.00	Min ⁶	475	345	-	9	
2324-T39	Boeing	12/21/78 Revised 03/25/98	Plate	20.00	32.00	Min ⁶ Min ⁹	470 490	425 400	- -	9 7	Standard 2024 solution treatment and quench followed by 11% nominal cold roll and 1% minimum stretcher stress relief.
				32.00	40.00	Min ⁶ Min ⁹	460 490	420 395	- -	9 7	
Alclad 2524-T3	Alcoa	02/27/97	Sheet & Plate	0.80	1.60	Min ⁹	405	270	15	-	
				1.60	3.30	Min ⁹	420	275	15	-	
				3.30	6.30	Min ⁹	425	275	15	-	
				6.30	7.90	Min ⁹	425	275	15	-	
++ 2624-T351	Alcoa	06/22/11 Revised 10/22/13	Plate	12.50	25.00	Min ⁶ Min ⁹	435 450	330 305	- -	14 13	<u>Fracture Toughness</u> ¹⁴ – Min K _{IC} or K _Q For thicknesses 20.00 through 40.00 mm L-T direction 46 MPa $\sqrt{m}$ T-L direction 45 MPa $\sqrt{m}$
				25.00	40.00	Min ⁶ Min ⁹	425 440	325 305	- -	14 13	
+ 2624-T39	Alcoa	01/28/11	Plate	20.00	40.00	Min ⁶ Min ⁹	470 490	425 400	- -	10 8	<u>Cold rolled - 10% and stretched - 1% after solution heat treating.</u> <u>Fracture Toughness</u> ¹⁴ – K _{IC} or K _Q For thicknesses 20.00-40.00 mm L-T direction 43 MPa $\sqrt{m}$ T-L direction 36 MPa $\sqrt{m}$

Footnotes appear beginning on page 46.

Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
+ 2824-T3511	Universal Alloy	06/25/14	Extrusion	6.30	12.50	*Min ⁶ *Min ⁹	490 470	370 330	12 -	- -	*Tentative Cross-sectional area less than or equal to 16,000 mm ² .
				12.50	20.00	*Min ⁶ *Min ⁹	505 470	380 325	- -	10 7	
				20.00	25.00	*Min ⁶ *Min ⁹	505 460	380 325	- -	10 7	
				25.00	40.00	*Min ⁶ *Min ⁹	510 455	385 325	- -	10 7	
				40.00	50.00	*Min ⁶ *Min ⁹	510 450	385 315	- -	10 7	
				50.00	60.00	*Min ⁶ *Min ⁹	510 440	385 315	- -	9 7	
2026-T3511	Alcoa	06/22/00	Extruded Rod, Bar, & Profiles	-	6.30	Min ⁶	455	330	11	-	
				6.30	12.70	Min ⁶	480	360	12	-	
				12.70	38.00	Min ⁶ Min ⁹	495 455	365 315	- -	10 7	
				38.00	57.00	Min ⁶ Min ⁹	505 440	370 300	- -	10 7	
				57.00	82.00	Min ⁶ Min ⁹	505 420	370 290	- -	9 7	
2027-T351	Alcan	12/08/04	Plate	12.50	40.00	Min ⁶ Min ⁹	470 460	360 315		12 12	
				40.00	60.00	Min ⁶ Min ⁹ Min ¹⁰	455 450 415	345 310 285		12 12 4	
2027-T3511	Alcan	11/29/04	Extruded Profiles	20.00	40.00	Min ⁶	515	395	-	12	Fracture Toughness ¹⁴ — min K _{IC} For thicknesses over 20.00 thru 40.00 mm L-T direction 44 MPa $\sqrt{m}$ T-L direction 42 MPa $\sqrt{m}$
+ Alclad 2029-T8	Alcoa	05/12/15	Sheet & Plate	1.60	4.00	*Min ⁶ *Min ⁹	420 420	380 370	8 9	- -	*Tentative
				4.00	6.30	*Min ⁶ *Min ⁹	420 420	380 370	10 10	- -	
				6.30	12.50	*Min ⁶ *Min ⁹	420 420	385 370	11 10	- -	
				12.50	16.00	*Min ⁶ *Min ⁹	435 440	400 385	- -	11 10	
2038-T4	Reynolds	10/10/82	Sheet	0.63	1.80	Min	275	140	20	-	Automotive sheet.
2038-T6	Reynolds	10/10/82	Sheet	0.63	1.80	Min	345	305	8	-	Automotive sheet.

Footnotes appear beginning on page 46.

Classification of the listed properties is as specified in the column headed "Basis"

	Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
		By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
+	2139-T84	Alcan Global ATI	03/23/11	Plate	25.00	40.00	*Min ⁶	450	425	-	10	* Tentative Material is cold worked in the range of 3-6% after solution heat treatment. <u>Stress Corrosion Resistance</u> For thicknesses 25.00 through 120.00 mm. C-rings and tensile specimens machined and tested in accordance with ASTM G47 shall show no evidence of stress corrosion failure when tested in the short transverse direction at 275 MPa and exposed for 30 days. <u>Fracture Toughness</u> ¹⁴ – Min K _{IC} For thicknesses 25.00 through 95.00 mm L-T direction 38 MPa $\sqrt{m}$ T-L direction 35 MPa $\sqrt{m}$ S-L direction 30 MPa $\sqrt{m}$ (from 50.00 mm) For thicknesses over 95.00 through 120.00 mm L-T direction 35 MPa $\sqrt{m}$ T-L direction 33 MPa $\sqrt{m}$ S-L direction 30 MPa $\sqrt{m}$
							*Min ⁹	460	420	-	7	
							*Min ¹⁰	435	380	-	4	
					40.00	95.00	*Min ⁶	455	425	-	8	
							*Min ⁹	470	420	-	6	
							*Min ¹⁰	425	380	-	3	
					95.00	120.00	*Min ⁶	450	405	-	7	
							*Min ⁹	460	405	-	5	
							*Min ¹⁰	420	365	-	3	
++	2050-T34	Constellium	01/25/16 Revised 08/04/17	Plate	12.50	50.00	*Min ⁹	360	250	-	15	*Tentative
					50.00	165.00	*Min ⁹	360	235	-	15	Solution heat treated and cold worked 3-4.5%.
+	2050-T82	Constellium	08/10/17	Plate	12.50	40.00	*Min ⁶	495	470	-	6	*Tentative Solution heat treated and cold worked 3-4.5% and artificially aged Properties are from material that was aged in a laboratory or test furnace for response to heat treatment <u>Stress Corrosion Resistance</u> For thickness 20.00 – 165.00 mm C-rings and Tensile specimens machined and tested in accordance with ASTM G47 shall show no evidence of stress corrosion failure when tested in the short transverse direction at 310 MPa and exposed for 30 days.
							*Min ⁹	505	460	-	4	
							*Min ⁶	495	460	-	6	
					40.00	50.00	*Min ⁹	505	450	-	4	
							*Min ¹⁰	490	420	-	2	
							*Min ⁶	495	460	-	6	
					50.00	80.00	*Min ⁹	495	450	-	4	
							*Min ¹⁰	490	420	-	2	
							*Min ⁶	490	460	-	5	
+	2050-T84	Constellium	01/20/14	Extruded Bar	40.00	150.00	*Min ⁹	495	450	-	4	*Tentative Solution heat treated, cold worked approximately 4% and artificially aged. <u>Stress Corrosion Resistance</u> For thicknesses over 40.00 thru 150.00 mm. Tensile specimens machined and tested in accordance with ASTM G47 shall show no evidence of stress corrosion failure when tested in the short transverse direction at 400 MPa and exposed for 30 days.
							*Min ⁶	490	455	-	4	
							*Min ⁹	490	435	-	3	
					40.00	150.00	*Min ¹⁰	475	405	-	1.5	
							*Min ⁶	490	455	-	4	
							*Min ⁹	490	435	-	3	
							*Min ¹⁰	475	395	-	1.5	
					40.00	150.00	*Min ⁶	585	565	-	8	
							*Min ⁹	490	440	-	3	

Footnotes appear beginning on page 46.

Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
++	2050-T84	Alcan Revised Constel- lilium	Plate	12.50	40.00	Min ⁶	505	475	-	8	<u>Stress Corrosion Resistance</u> For thicknesses 20.00 – 165.00 mm
						Min ⁹	510	460	-	6	
				40.00	50.00	Min ⁶	495	460	-	8	Direct C-rings and Tensile specimens machined and tested in accordance with ASTM G47 shall show no evidence of stress corrosion failure when tested in the short transverse direction at 310 Mpa and exposed for 30 days.
						Min ⁹	505	450	-	6	
						Min ¹⁰	490	420	-	2	
				50.00	80.00	Min ⁶	495	460	-	7	<u>Fracture Toughness</u> ¹⁴ – Min K _{IC}
						Min ⁹	495	450	-	5	
						Min ¹⁰	490	420	-	2	
				80.00	100.00	Min ⁶	490	460	-	6	For thicknesses over 12.50 thru 40.00 mm
						Min ⁹	495	450	-	3	
						Min ¹⁰	485	415	-	1.5	
				100.00	125.00	Min ⁶	490	455	-	5	L-T direction 36 MPa $\sqrt{m}$ T-L direction 32 MPa $\sqrt{m}$ S-L direction 27 MPa $\sqrt{m}$
						Min ⁹	490	440	-	3	
						Min ¹⁰	475	405	-	1.5	
				125.00	165.00	Min ⁶	490	455	-	4	For thicknesses over 40.00 thru 50.00 mm
						Min ⁹	490	440	-	3	
						Min ¹⁰	475	405	-	1.5	
											L-T direction 34 MPa $\sqrt{m}$ T-L direction 30 MPa $\sqrt{m}$ S-L direction 25 MPa $\sqrt{m}$
											For thicknesses over 50.00 thru 80.00 mm
											L-T direction 31 MPa $\sqrt{m}$ T-L direction 27 MPa $\sqrt{m}$ S-L direction 25 MPa $\sqrt{m}$
											For thicknesses over 80.00 thru 100.00 mm
											L-T direction 29 MPa $\sqrt{m}$ T-L direction 25 MPa $\sqrt{m}$ S-L direction 23 MPa $\sqrt{m}$
											For thicknesses over 100.00 thru 125.00 mm
											L-T direction 27 MPa $\sqrt{m}$ T-L direction 23 MPa $\sqrt{m}$ S-L direction 23 MPa $\sqrt{m}$
											For thicknesses over 125.00 thru 150.00 mm
											L-T direction 24 MPa $\sqrt{m}$ T-L direction 22 MPa $\sqrt{m}$ S-L direction 20 MPa $\sqrt{m}$
											For thicknesses over 150.00 thru 165.00 mm
											L-T direction 24 MPa $\sqrt{m}$ T-L direction 21 MPa $\sqrt{m}$ S-L direction 18 MPa $\sqrt{m}$

Footnotes appear beginning on page 46.



Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
+ 2050-T852	Aubert & Duval	01/21/14 Revised 10/02/15	Die Forging	6.35	38.10	Min ⁶ Min ⁹	515 525	475 485	- -	8 7	Fracture Toughness ¹⁴ – K _{IC} or K _Q For thicknesses 6.35-38.10 mm L-T direction 35 MPa $\sqrt{m}$ T-L direction 32 MPa $\sqrt{m}$
				38.10	50.80	Min ⁶ Min ⁹ Min ¹⁰	515 525 515	475 485 440	- - -	8 7 4	For thicknesses 38.10-50.80 mm L-T direction 35 MPa $\sqrt{m}$ T-L direction 32 MPa $\sqrt{m}$
				50.80	76.20	Min ⁶ Min ⁹ Min ¹⁰	510 510 505	470 470 440	- - -	7 5 3	For thicknesses 50.80-76.20 mm L-T direction 35 MPa $\sqrt{m}$ T-L direction 32 MPa $\sqrt{m}$
				76.20	101.60	Min ⁶ Min ⁹ Min ¹⁰	510 505 505	470 460 435	- - -	6 5 3	For thicknesses 76.20-101.60 mm L-T direction 32 MPa $\sqrt{m}$ T-L direction 29 MPa $\sqrt{m}$ S-L direction 22 MPa $\sqrt{m}$
				101.60	127.00	Min ⁶ Min ⁹ Min ¹⁰	510 505 495	460 455 425	- - -	5 5 2	For thicknesses 101.60-127.00 mm L-T direction 27 MPa $\sqrt{m}$ T-L direction 23 MPa $\sqrt{m}$ S-L direction 21 MPa $\sqrt{m}$
				127.00	152.40	Min ⁶ Min ⁹ Min ¹⁰	505 495 490	460 450 420	- - -	5 5 2	For thicknesses 127.00-152.40 mm L-T direction 25 MPa $\sqrt{m}$ T-L direction 22 MPa $\sqrt{m}$ S-L direction 21 MPa $\sqrt{m}$
				152.40	177.80	Min ⁶ Min ⁹ Min ¹⁰	505 490 490	455 440 420	- - -	4 4 2	For thicknesses 152.40-177.80 mm L-T direction 23 MPa $\sqrt{m}$ T-L direction 20 MPa $\sqrt{m}$ S-L direction 19 MPa $\sqrt{m}$
				177.80	203.10	Min ⁶ Min ⁹ Min ¹⁰	495 490 485	455 435 415	- - -	4 4 2	For thicknesses 177.80-203.10 mm L-T direction 23 MPa $\sqrt{m}$ T-L direction 20 MPa $\sqrt{m}$ S-L direction 19 MPa $\sqrt{m}$
				203.10	228.60	Min ⁶ Min ⁹ Min ¹⁰	495 485 485	450 435 415	- - -	4 4 2	For thicknesses 203.10-228.60 mm L-T direction 23 MPa $\sqrt{m}$ T-L direction 20 MPa $\sqrt{m}$ S-L direction 19 MPa $\sqrt{m}$
				228.60	254.00	Min ⁶ Min ⁹ Min ¹⁰	490 475 475	440 425 405	- - -	4 4 1.5	For thicknesses 228.60-254.00 mm L-T direction 22 MPa $\sqrt{m}$ T-L direction 20 MPa $\sqrt{m}$ S-L direction 18 MPa $\sqrt{m}$
+ 2055-T84	Alcoa	01/14/14	Extrusion	1.00	3.00	*Min ⁶	565	540	5	-	*Tentative
				3.00	6.00	*Min ⁶ *Min ⁹	575 580	545 540	6 5	- -	Solution heat treated and cold worked in the range 2-5% and artificially aged.
				6.00	12.50	*Min ⁶ *Min ⁹	585 580	550 540	7 5	- -	Cross Sectional Area less than or equal to 11900 mm ² and Circle Size less than or equal to 370 mm.
				12.50	20.00	*Min ⁶ *Min ⁹	600 580	565 540	- -	7 4	Fracture Toughness ¹⁴ – Min. K _{IC} or K _Q
				20.00	30.00	*Min ⁶ *Min ⁹	605 580	580 540	- -	7 4	For thicknesses over 20.00 through 40.00 mm L-T direction 24 MPa $\sqrt{m}$ T-L direction 21 MPa $\sqrt{m}$
				30.00	40.00	*Min ⁶ *Min ⁹	620 580	595 540	- -	7 4	
Alclad 2056-T3	Pechiney	12/10/03	Sheet	1.60	3.20	Min ⁹	430	285	15	-	
				3.20	6.00	Min ⁹	430	275	16	-	

Footnotes appear beginning on page 46.

Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
+ 2060-T86	Alcoa	06/03/13	Plate	20.00	40.00	*Min ⁶ *Min ⁹	505 505	470 435	- -	8 5	*Tentative Solution heat treated, cold worked approximately 6% and artificially aged. <u>Fracture Toughness</u> ¹⁴ – Min K _{IC} or K _Q For thicknesses 20.00-40.00 mm L-T direction 42 MPa $\sqrt{m}$ T-L direction 36 MPa $\sqrt{m}$
+ 2065-T84	Constellium	04/16/14	Extrusion	1.00 6.00	6.00 12.50	Min ⁶ Min ⁶	600 600	570 580	6 6	- -	*Tentative Solution heat treated, cold worked approximately 3-4% and artificially aged.
2090-T3	Alcoa	02/28/89 Revised 03/23/99	Sheet	0.80	6.30	Min	315	215	6	-	
2090-T83	Alcoa	03/15/88 Revised 03/09/98	Sheet	0.80	3.20	Min ⁶ Min ⁹	530 505	485 455	3 5	- -	
				3.20	6.30	Min ⁶ Min ⁹	515 505	485 455	4 5	- -	
++ 2090-T86	Alcoa	08/11/88 Revised 07/30/90 Reactivate 07/18/12	Extrusion	- 3.20 6.30	3.20 6.30 12.50	Min ⁶ Min ⁶ Min ⁶ Min ⁹	540 540 550 525	490 490 505 470	4 5 5 -	- - - -	
+ 2195-T34	Rio Tinto Alcan	06/07/10	Plate	12.70	57.00	Min ⁹	360	250	-	12	Solution heat treated and cold worked in the range of 3-5%
2195-T8	Constellium	03/09/12 Revised 01/20/15	Sheet & Plate	3.20	12.70	Min ⁶ Min ⁹	565 550	540 525	6 6	- -	
2195-T82	Rio Tinto Alcan	10/11/09	Plate	12.70 40.00	40.00 57.00	Min ⁶ Min ⁹ Min ⁶ Min ⁹ Min ¹⁰	550 565 530 550 560	515 525 505 495 475	- - - - -	5 4 5 4 2	<u>Stress Corrosion Resistance</u> For thicknesses over 20.00 thru 57.00 mm. C-rings or Tensile specimens machined and tested in accordance with ASTM G47 shall show no evidence of stress corrosion failure when tested in the short transverse direction at 310 MPa and exposed for 30 days. <u>Compressive Yield Strength</u> For thicknesses over 12.50 thru 57.00 mm in LT direction, Min 525 MPa.
+ 2195-T841	Constellium Global ATI	06/24/11	Plate	12.50	60.00	*Min ⁹	490	435	-	8	*Tentative Developed to meet armor plate requirements of Mil-STD-32341. Material is solution heat treated, cold worked in the range 3-5%, and under-aged.

Footnotes appear beginning on page 46.

Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
+ 2395-T84	Universal Alloy	02/10/16	Extrusion	1.00	3.20	*Min ⁶ *Min ⁹	580 585	540 540	6 5	- -	*Tentative Cross-sectional area less than or equal to 15000 mm ² and circle size less than or equal to 410 mm. Solution heat treated and cold worked in the range 2-5% and artificially aged.
				3.20	6.30	*Min ⁶ *Min ⁹	585 585	540 540	6 5	- -	
				6.30	12.50	*Min ⁶ *Min ⁹	585 585	545 540	6 5	- -	
				12.50	40.00	*Min ⁶ *Min ⁹	620 585	570 540	- -	6 4	
++ 2196-T8511	Alcan Constellium Global ATI	10/04/07 Revised 03/29/12 Revised 10/27/16	Extrusion	1.00	1.60	*Min ⁶	515	475	6	-	*Tentative
				1.60	3.20	*Min ⁶	525	475	6	-	
				3.20	6.30	*Min ⁶	525	490	7	-	
				6.30	25.00	*Min ⁶	540	490	5	4	
2297-T87	McCook Metals	06/21/00 Revised 06/03/04	Plate	40.00	50.00	Min ⁶ Min ⁹ Min ¹⁰	440 455 450	400 415 395	- - -	9 7 2	<u>Stress Corrosion Resistance</u> 30 days at 205 MPa when tested in the ST direction per ASTM G47. <u>Exfoliation Corrosion Resistance</u> See footnote 15.b. <u>Fracture Toughness</u> ¹⁴ — Min K _{IC} For thicknesses over 40.00 thru 80.00 mm L-T direction 35 MPa√m T-L direction 30 MPa√m S-L direction 22 MPa√m For thicknesses over 80.00 thru 100.00 mm L-T direction 34 MPa√m T-L direction 30 MPa√m S-L direction 22 MPa√m For thicknesses over 100.00 thru 125.00 mm L-T direction 33 MPa√m T-L direction 29 MPa√m S-L direction 20 MPa√m For thicknesses over 125.00 thru 160.00 mm L-T direction 32 MPa√m T-L direction 27 MPa√m S-L direction 20 MPa√m
				50.00	60.00	Min ⁶ Min ⁹ Min ¹⁰	435 440 440	395 400 385	- - -	8 6 2	
				60.00	80.00	Min ⁶ Min ⁹ Min ¹⁰	425 440 425	395 400 380	- - -	8 6 2	
				80.00	100.00	Min ⁶ Min ⁹ Min ¹⁰	430 430 405	395 395 370	- - -	4 3 1.5	
				100.00	125.00	Min ⁶ Min ⁹ Min ¹⁰	420 420 400	385 385 360	- - -	4 3 1.5	
				125.00	160.00	Min ⁶ Min ⁹ Min ¹⁰	415 415 395	380 380 360	- - -	4 3 1.5	

Footnotes appear beginning on page 46.

Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
2397-T87	Alcoa	02/12/03 Revised 08/17/05	Plate	80.00	100.00	*Min ⁶	425	395	-	4	*Tentative <u>Stress Corrosion Resistance</u> See footnote 4.b. <u>Exfoliation Corrosion Resistance</u> See footnote 15.b. <u>Fracture Toughness</u> ¹⁴ - Min K _{IC} For thicknesses over 80.00 thru 100.00 mm L-T direction 34 MPa $\sqrt{m}$ T-L direction 30 MPa $\sqrt{m}$ S-L direction 22 MPa $\sqrt{m}$ For thicknesses over 100.00 thru 125.00 mm L-T direction 35 MPa $\sqrt{m}$ T-L direction 29 MPa $\sqrt{m}$ S-L direction 20 MPa $\sqrt{m}$ For thicknesses over 125.00 thru 150.00 mm L-T direction 32 MPa $\sqrt{m}$ T-L direction 27 MPa $\sqrt{m}$ S-L direction 20 MPa $\sqrt{m}$ Note: Fracture toughness test parameters are defined in AMS 4328.
						*Min ⁹	425	395	-	4	
						*Min ¹⁰	415	370	-	1.5	
				100.00	125.00	Min ⁶	425	385	-	5	
						Min ⁹	425	385	-	4	
						Min ¹⁰	415	380	-	1.5	
				125.00	150.00	Min ⁶	415	380	-	5	
						Min ⁹	415	380	-	4	
						Min ¹⁰	395	360	-	1.5	
2098-O	Pechiney	06/20/03	Plate	6.30	8.00	Max	240	170	11	-	<u>Stress Corrosion Resistance</u> Direct tensile specimens machined and tested in accordance with ASTM G47 shall show no evidence of Stress Corrosion failure when tested in the long transverse direction at 240 MPa and exposed for 30 days. <u>Fracture Toughness</u> ¹³ - Min K _{IC} For thicknesses over 6.30 thru 8.00 mm L-T direction 110 MPa $\sqrt{m}$ T-L direction 82 MPa $\sqrt{m}$
2098-T8	Rio Tinto Alcan	03/21/08	Sheet	3.20	6.30	Min ⁶	530	490	6	-	
						Min ⁹	510	475	6	-	
2098-T82	Pechiney	06/20/03	Plate	6.30	8.00	Min ⁶	505	470	7	-	
						Min ⁹	505	470	6	-	
2198-T8	Alcan	03/21/07 Revised 10/21/08	Sheet	1.60	3.20	Min ⁶	470	425	8	-	
						Min ⁹	460	405	9	-	
				3.20	6.30	Min ⁶	490	440	8	-	
						Min ⁹	475	425	9	-	

Footnotes appear beginning on page 46.

Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
+ 2099-T81	Alcoa	08/01/11	Extrusion	10.00	35.00	Min ⁶ Min ⁹	505 435	405 350	-	6 6	Stretched approximately 1-3 % and und- eraged. <u>Stress Corrosion Resistance</u> Material shall be capable of passing the stress corrosion cracking test described in ASTM G47 when tested in the LT direc- tion at a stress of 265 MPa for 30 days. <u>Exfoliation Corrosion Resistance</u> Specimens shall not exhibit exfoliation corrosion at a T/2 plane greater than that illustrated by Photo 2 (EB) from Figure 2 of ASTM G34 when specimens are exposed for 2 weeks according to the procedures in ASTM G85 Annex A2, using the dry-bottom MASTMAASIS Test Method. <u>Fracture Toughness</u> ¹⁴ – Min K_{IC} or K_Q For thicknesses 12.50-35.00 mm L-T direction 49 MPa$\sqrt{m}$
2099-T83	Alcoa	01/07/05 Revised 08/16/10	Extrusion	1.20	6.30	Min ⁶	515	460	6	-	<u>Stress Corrosion Resistance</u> For ST specimens taken from section thicknesses 20.00 mm and greater, see footnote 4.b. <u>Exfoliation Corrosion Resistance</u> See footnote 15.b. Note: For Al-Li alloys, specimens are exposed for 2 weeks ac- cording to the procedures in ASTM G 85 Annex A2, using the dry-bottom MASTMAASIS Test Method. The solu- tion used for exposure by ASTM G 34, the EXCO Test, has been determined to be inappropriate for Al-Li alloys. For further information on this review ASTM G 112 paragraph 6.3.1 which describes limitations on this test method for Al-Li alloys.
				6.30	12.50	Min ⁶	540	475	7	-	
				12.50	25.00	Min ⁶ Min ⁹	545 505	490 450	- -	6 6	
				25.00	80.00	Min ⁶	550	495	-	6	
2099-T86	Alcoa	07/31/09	Plate	12.50	50.00	Min ⁶ Min ⁹	490 495	435 495	-	5 4	Solution heat treated, cold worked ap- proximately 6% and artificially aged. <u>Stress Corrosion Resistance</u> For ST specimens, see footnote 4.f. For LT specimens, see footnote 4.g. <u>Exfoliation Corrosion Resistance</u> Specimens shall not exhibit exfoliation corrosion at a T/10 plane greater than that illustrated by Photo 2 (EB) from Figure 2 of ASTM G34 when specimens are exposed for 2 weeks according to the procedures in ASTM G85 Annex A2, using the dry-bottom MASTMAASIS Test Method. <u>Fracture Toughness</u> ¹⁴ – Min K_{IC} or K_Q For thicknesses 25.00-50.00 mm L-T direction 33 MPa$\sqrt{m}$ T-L direction 27 MPa$\sqrt{m}$

Footnotes appear beginning on page 46.

Classification of the listed properties is as specified in the column headed "Basis"

Alloy Temper	Registered		Product	Thickness, mm		Tensile Strength, MPa			Elongation Percent in ²¹		Remarks ²
	By	Date		Over	Thru	Basis ¹	Ult.	Yield	50mm	5D or 5.65 $\sqrt{A}$	
2199-T8	Alcoa	06/01/07	Sheet & Plate	3.20	8.00	Min ⁶ Min ⁹	420 425	360 345	9 6	- -	
				8.00	14.00	Min ⁶ Min ⁹	420 435	360 350	10 7	9 6	
+ 2199-T86	Alcoa	06/16/11	Plate	20.00	30.00	*Min ⁶ *Min ⁹	440 455	400 400	- -	8 7	* Tentative Solution heat treated, cold worked approximately 6% and artificially aged. <u>Exfoliation Corrosion Resistance</u> Specimens shall not exhibit exfoliation corrosion at a T/10 plane greater than that illustrated by Photo 2 (EA) from Figure 2 of ASTM G34 when specimens are exposed for 2 weeks according to the procedures in ASTM B85 Annex A2, using the dry-bottom MASTMAASIS Test Method. <u>Fracture Toughness</u> ¹⁴ – Min. K_{IC} or K_Q For thicknesses 20.00 through 30.00 mm L-T direction 53 MPa$\sqrt{m}$ T-L direction 47 MPa$\sqrt{m}$
3002-O	Alcoa	05/17/74	Sheet	0.63	1.60	Min Max	75 110	20 -	* -	- -	
3102-O	AATD	03/19/80	Drawn Seam-less Tube (Coiled & Straight)	0.50	1.20	Min Max	85 115	30 -	* -	- -	<u>*Full Section</u> <u>*Cut Out</u> 30% 20% - - 35% 25% - -
3102-H112	Bohn	04/07/76	Extruded Coiled Tube	0.63	1.20	Min Max	75 125	30 -	25 -	- -	
3003-H121	Howmet	02/13/79	Sheet	0.70	0.90	Min Max	115 160	80 -	16 -	- -	
3003-H183	Alcoa	12/21/53	Tube	-	-	Min	185	-	-	-	
3003-H191	Alcoa	12/01/64	Sheet	-	-	Min Max	205 240	- -	- -	- -	
+ 3003-H22	Alcoa	04/12/11	Sheet	1.10	1.60	Min ⁶	115	85	5	-	
				1.60	6.30	Min ⁶	115	85	7	-	Used for tread plate applications.
3003-H231	Reynolds	01/03/91	Sheet	1.60	2.50	Min	130	105	5	-	
				2.50	4.00	Min	130	105	6	-	Used for tread plate applications.
				4.00	5.00	Min	130	105	7	-	
3003-H271	Alcoa	08/08/56	Sheet	-	-	Min	170	-	7	-	

Footnotes appear beginning on page 46.