International Temper Designation Systems for Wrought Aluminum Alloys:

Part II – Thermally Treated (T Temper) Aluminum Alloys

By Joseph C. Benedyk, Editor

Introduction

As was published earlier in the October 2009 issue of *Light Metal Age*, Part I of this article series dealt with international temper designation systems for strain hardenable (H temper) aluminum alloys and the actions taken by international organizations to make aluminum alloy standards more universal.[1] This article, Part II of the series, deals with thermally treated (T temper) aluminum alloys and describes the latest T temper designations registered by the Aluminum Association, the main body registering aluminum alloy compositions and temper designations in its American National Standards Institute (ANSI) H35.1 standard. The Aluminum Association serves as the secretariat for the Accredited Standards Committee (ASC) H35 and is responsible for administering the registration of alloy designations and chemical composition limits and mechanical properties of cast and wrought aluminum alloys along with their accompanying temper designations.

As noted by key staff members of the Aluminum Association in an earlier *Light Metal Age* article, as late as 2003 there was no international accord for aluminum and aluminum alloy temper designations or temper registrations that served as product standards.[2] However, the rapid pace of global restructuring of the aluminum industry has made it imperative that aluminum and aluminum alloy standards become more universal in order to assure consistency in the purchase and use of aluminum products worldwide. In this respect, the ANSI H35.1(M) standard was the basis for ISO 2107, which is an attempt to unify the worldwide aluminum temper designation system. To this end, the ISO (International Organization for Standardization) subcommittee SC 9 (Symbolization) of ISO technical committee TC 79 (Light Metals and Their Alloys) has published a new document in 2007 (ISO 2107:2007)[3] establishing temper designations as required for identification for all product forms of wrought aluminum and aluminum alloys as a revision of their previous document on temper designations, published as ISO 2107:2004 (withdrawn). Participating in the work of TC 79/SC 9 on ISO 2107:2007 under the USA(ANSI) secretariat, chaired by Michael H. Skillingberg of the Aluminum Association, were 15 countries and two observing countries, all involved in the international aluminum industry and having a vested interest in aluminum standardization.

In 2009, the Aluminum Association published the latest version of the ANSI H35.1 standard, *American National Standard Alloy & Temper Designation Systems for Aluminum,* as a revision of the 2006 version.[4] This 2009 edition, designated as the ANSI H35.1/H35.1(M) standard, combines the U.S. and metric versions of this publication, as the metric edition (ANSI H35.1M) has not been published as a separate document since 2004. This ANSI H35.1(M) standard is also incorporated into the Aluminum Association's, *Aluminum Standards and Data 2009*.[5] As described in both: "Since there is no international accord on designation and registration of tempers for wrought aluminum alloys and wrought aluminum alloy products, reference to ANSI H35.1/H35.1(M) may not always reflect actual properties and characteristics associated with the particular aluminum alloy temper." This cautionary note applies to both strain hardenable (H temper) and thermally treated (T temper) aluminum alloys, though especially to the latter. In fact, most of the changes incorporated in the ANSI H35.1/H35.1(M)-2009 standard over the 2006 version apply to thermally treated (T temper) aluminum alloys.

It seems that, in spite of the significant international cooperation rendered on aluminum "symbolization", differences in temper designations for wrought aluminum and aluminum alloys still exist from country to country. In some cases, metallurgists may feel comfortable with older temper designations, which have varied from country to country. Even between the U.S. and European member countries of CEN (Comité Européen de Normalisation/European Committee for Standardization), where the EN 515 standard is very similar to the wrought alloy portion of ANSI H35.1(M), some differences are noted in the respective temper designations and standards as late as 2008.[6]

Perhaps it is obvious to metallurgists that the T temper aluminum alloys—2xxx, 6xxx, and 7xxx series—pose special challenges over H temper aluminum alloys in achieving optimum combinations of mechanical properties that also provide good corrosion resistance. Both H temper and T temper classes of aluminum alloys are valued for their ability to attain a high strength-to-weight ratio, H temper alloys by work hardening and T temper alloys by precipitation hardening. However, the precipitation hardening process is rather more complex than that of work hardening (a point no doubt arguable from the viewpoint of a mill metallurgist), involving appropriate solution heat treatment, quenching, and artificial aging, sometimes in combination with cold working introduced before or after artificial aging. When considering costs to achieve given mechanical property limits based on alloy chemistry and metallurgical processing, it is no wonder that the T temper series of aluminum alloys generally sell at a premium to the H temper series.

Definitions and Subdivisions of T Temper Designations

As part of the basic temper designations for aluminum and aluminum alloys (Table I), the T temper applies to all standard 2xxx, 6xxx, and 7xxx aluminum alloy products, as well as to products made from special lithium-bearing aluminum alloys (such as 2090 and 8090) that are thermally treated, with or without supplementary strain hardening, to produce stable tempers.

Subdivisions of the T temper for wrought aluminum alloys are based on assigning to a thermally treatable alloy

F	As fabricated and no mechanical properties specified (F stands alone)
O	Annealed to obtain lowest strength temper (O may be followed by a digit to indicate an annealed condition with special characteristics)
H	Strain-hardened wrought products with or without additional thermal treatment to reduce strength (H always is followed by two or more digits)
W	Solution heat-treated (W is an unstable temper due to natural aging at room temperature after solution heat-treatment)
T	Thermally heat-treated to produce stable tempers other than F, O, or H (T is always followed by one or more digits)

Table I. Basic temper designations per ANSI H35.1/H35.1(M)-2009 and adopted by the European EN 515 and ISO 2107 temper designation systems.

the letter T followed by numerals 1 through 10, i.e., T1 through T10 (Table II). This basic T temper subdivision like the H temper subdivision has been utilized since 1948 in the U.S. and published in the 1962 issue of the ANSI H35.1 standard. The latest revision of the ANSI H35.1 standard is now being adopted by many countries that employ the EN 515 and ISO 2107 standards.

Important considerations to these definitions define the method of achieving solution heat treatment and the importance of control of natural aging between or after operations. Solution heat treatment is normally achieved in a heat treat furnace by heating products long enough at a temperature that allows the age hardening constituents to enter solid solution and cooling rapidly enough to hold these constituents in solid solution. However, as stated in the standard: "Some 6xxx and some 7xxx series alloys attain the same specified mechanical properties whether furnace solution heat treated or cooled from an elevated temperature shaping process at a rate rapid enough to hold constituents in solution. In such cases the temper designations T3, T4, T6, T7, T8, and T9 are used to apply to either process and are appropriate designations." This expanded definition is of particular importance to extruders who utilize press quenching of 6xxx and 7xxx alloys from hot extrusion temperatures and do not employ furnace heat treatment to achieve solution heat treatment to achieve T3, T4, T6, T7, T8, and T9 mechanical property minimums. In fact Aluminum Extruders Council (AEC) members have fought and succeeded in incorporating this definition of solution heat treatment in ANSI H35.1 for some time.

In view of this expanded definition of solution heat treatment, two questions come to mind. The first is what if any differences or advantages/disadvantages are achieved in properties with T3, T4, T6, T7, T8, and T9 tempers by employing press solution heat treatment in extrusion, forging, or other hot working processes and subsequent quenching over furnace heat treatment and quenching of age hardenable aluminum alloys? It should be noted that not all T5/T10 (or T1/T2) processes achieve a solution heat treatment since neither the temperature nor the cooling rate are required to be sufficient for solution heat treatment. Also there is a long standing industry tradition of marketing 6xxx and some 7xxx press quenched and aged extrusions with T temper designations that have satisfied producers and users as being equivalent to furnace heat treated extrusions in properties but lower in cost.

Additional Digits for T Tempers – Stress Relieved Tempers

Additional digits are assigned after the basic T tempers listed in Table II in ANSI H35.1/H35.1(M)-2009 to designate stress relief by stretching (T_51, T_510, or T_511), compressing (T_52), or combined stretching and compressing (T_54) after solution heat treatment or after cooling from an elevated temperature shaping process (Table III).[4,5] As noted in the ANSI H35.1/H35.1(M) standard, these same additional digits may be added to the W temper of the alloy to indicate unstable solution heat treated and stress relieved tempers.

These additional stress relieved tempers are also standard in EN 515 and ISO 2107 with some minor exceptions, e.g., EN 515 assigns special additional digits that are not in ANSI H35.1/H35.1(M)-2009 to the T8 temper

Temper	Definition
T1	Cooled from an elevated temperature shaping process and naturally aged
T2	Cooled from an elevated temperature-shaping process, cold worked, and naturally aged
T3	Solution heat treated, cold worked, and naturally aged
T4	Solution heat treated and naturally aged
T5	Cooled from an elevated temperature-shaping process and artificially aged
T6	Solution heat treated and artificially aged
T7	Solution heat treated and artificially overaged
T8	Solution heat treated, cold worked, and artificially aged
T9	Solution heat treated, artificially aged, and cold worked
T10*	Cooled from an elevated temperature shaping process, cold worked, and artificially aged

*T10 is designated in ANSI H35.1/H35.1(M) but not in EN 515 or ISO 2107.

Table II. Short definitions of the subdivisions of T temper for thermally treated wrought aluminum alloys per ANSI H35.1/H35.1(M)-2009 and adopted by the European EN 515 and ISO 2107 temper designation systems.

Additional Digits for T Tempers	Wrought Product Type	Stress Relief Process	Permanent Set
T_51*	Plate	Stretching	1.5-3%
T_51*	Rolled or cold finished rod and bar	Stretching	1-3%
T_51*	Die or ring forgings and rolled rings	Stretching	1-5%
T_510*	Extruded rod, bar, profiles, and tube	Stretching	1-3%
T_510*	Drawn tube	Stretching	0.5-3%
T_511**	Extruded rod, bar, profiles, and tube	Stretching	1-3%
T_511**	Drawn tube	Stretching	0.5-3%
T_52	All products	Compressing	1-5%
T_54	Die forgings	Restriking cold in finish die	--

*No further straightening after stretching.

**Minor straightening after stretching to comply with standard tolerances.

Table III. Additional digits for stress relieved T temper aluminum alloy products when stress relieved after solution heat treatment or after cooling from an elevated temperature shaping process per ANSI H35.1/H35.1(M)-2009.

of 6063 drawn tube and the lithium-bearing 2091 and 8090 alloys, thus:[6]

•T832 (6063 drawn tube: solution heat treated, cold worked a controlled specific amount, and then artificially aged)

• T841 (2091 and 8090 sheet and strip: solution heat treated, cold worked, and artificially underaged)

•T84151 (2091 and 8090 plate: solution heat treated, stress relieved by stretching to a permanent set of 1.5-3% and then artificially underaged)

Additional Digits for T7 Temper Variations

The T7 temper is assigned to thermally heat treated wrought aluminum alloys, mainly 7xxx alloys, which are artificially overaged to obtain a compromise among exfoliation corrosion resistance, stress corrosion resistance, fracture toughness, and tensile strength. The additional digit for T7, i.e., T7_ indicates how much the alloy is overaged. The latest versions of ANSI H35.1/H35.1(M), EN 515, and ISO 2107 have paid special attention to the assigning of T7 temper variations, used mainly on aerospace products. Table IV lists the T7_ designations that apply to standardized aluminum alloy products, and Figure 1 demonstrates qualitatively the evolution of strength and corrosion resistance from T79 (slight overaging) to T73 (full overaging) in an alloy-T7 product combination.

In most cases, aluminum alloys that are heat treated to T7_ tempers are also stress relieved and, therefore, may have additional digits appended as indicated in Table III, i.e., T7_51, T7_510, T7_511, T7_52, and T7_54. As defined in Table IV and shown in Figure 1, ANSI H35.1/H35.1(M)-2009 ascribes varying degrees of corrosion resistance to the T7_ tempers;[4,5] the EN 515 standard specifically describes T73 as achieving the "best stress corrosion resistance" and T76 as achieving "good exfoliation corrosion resistance," but makes no mention of "corrosion resistance" in describing the T74 or T79 tempers.[6]

Response to Heat Treatment and Temper Conversion

In some applications of wrought T temper aluminum alloys, there is need for the producer/supplier or purchaser/user to demonstrate adequate response to heat treatment or temper conversion capability. For demonstration of heat treatment response, the product is furnace heat treated from an annealed (O, O1, etc.) or F temper to a T4, T6, and T7_ condition; these test tempers have the designation T_2 as, for example, T42, T62, and T7_2.[4,5]

For demonstration of temper conversion capability, the temper designation T_2 is also used but with the term "Capability Demonstration" appended to the specified and final tempers; for example, T4 to T62 Capability Demonstration for response to aging, T6 to T732 Capability Demonstration for response to overaging, etc.[4,5]

T Tempers for Wrought Aluminum Alloys and Products

Particular T temper designations do not apply commercially to all aluminum alloys or their product forms. Table V attempts to summarize the commonly used applications of T temper designations to particular wrought thermally treated aluminum alloys and product forms. This table is not all inclusive, but attempts to capture most of the common applications of aluminum alloy products that bear T temper designations.[5,6]

Additional Digits for T7 Temper	Definition
T79	Very limited overaging to achieve some improved corrosion resistance with limited reduction in strength as compared with the T6 temper.
T76	Limited overaging to achieve moderate corrosion resistance with some reduction in strength. The T76 temper has lower strength and better corrosion resistance than the T79 temper.
T74	Overaging to achieve good corrosion resistance with a greater reduction in strength than for T76. Strength and corrosion resistance of T74 are between those of T73 and T76 tempers.
T73	Full overaging to achieve the best corrosion resistance of all T7 tempers with a greater reduction in strength than the T74 temper.
T77*	Aged condition providing strength at or near T6 temper and corrosion resistance similar to T76 temper.

*T77 is designated in ANSI H35.1/H35.1(M)-2009 temper but not in EN 515 or ISO 2107.

Table IV. Assigned additional digits for T7 temper per ANSI 35.1/H35.1(M)-2009.

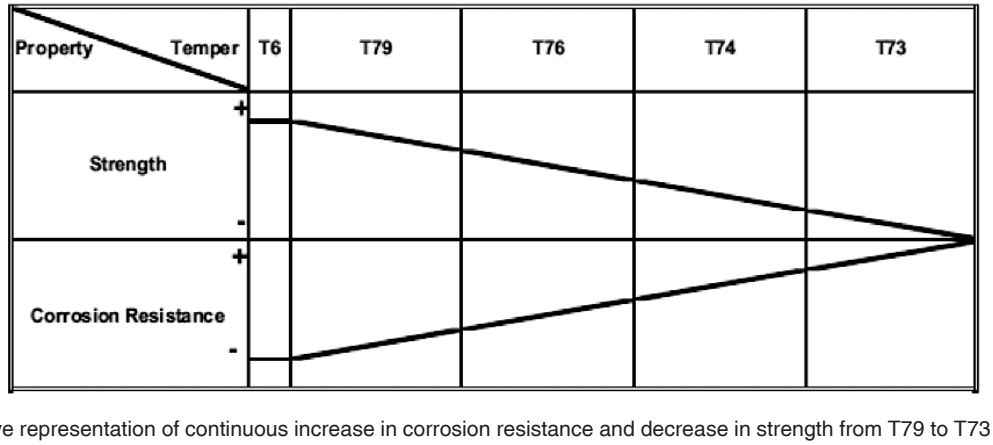

Figure 1. Qualitative representation of continuous increase in corrosion resistance and decrease in strength from T79 to T73 (T77 excluded).[4,5]

Temper	Designation	T Temper Alloy	Product Forms
F	As Fabricated	All	All
O	Annealed	All	All
O1	Thermally treated at ~time/temperature for solution treatment (ST) and slow cooled to room temperature	All	Products to be machined prior to solution treatment, no mechanical property limits
W	Solution heat treated (unstable temper)	All	All
T	Thermally treated to produce stable tempers other than F, O, or H	All	All
T1	Cooled from an elevated shaping process and naturally aged to a substantially stable condition	6061, 6063, 6105, 6351, 6463	Extruded tube, wire, rod, bar, and profiles
T3	Solution heat treated*, cold worked, and naturally aged to a substantially stable condition	2011, 2014, Alclad 2014, Alclad 2024	Sheet; rolled or cold finished rod, bar, or wire; Drawn tube and extruded tube, wire, rod, bar, and profiles (2024 only)
T31	Solution heat treated*, cold worked ~1%, and naturally aged to a substantially stable condition	2219, Alclad 2219	Sheet; extruded tube, wire, rod, bar, and profiles
T351	Solution heat treated*, stretched a controlled amount for stress relief, and naturally aged (no further straightening after stretching)	2024, Alclad 2024, 2124, 2219	Plate; rolled or cold finished bar (2024 only)
T3510	Solution heat treated*, stretched a controlled amount for stress relief, and naturally aged (no further straightening after stretching)	2024, 2219	Extruded tube, wire, rod, bar, and profiles
T3511	Same as T3510 except minor straightening allowed after stretching to comply with standard tolerances	2024, 2219	Extruded tube, wire, rod, bar, and profiles
T361 (formerly T36)	Solution heat treated*, cold worked ~6%, and naturally aged	2024, Alclad 2024	Sheet and plate
T37	Solution heat treated*, cold worked ~7%, and naturally aged	2219	Sheet and plate
T4	Solution heat treated* and naturally aged	All (with exceptions)	All (most with exceptions)
T42	Solution heat treated in a furnace from annealed or F temper and naturally aged to demonstrate response to heat treatment	All	All
T451	Solution heat treated*, stretched a controlled amount (product dependent) for stress relief, and naturally aged (no further straightening after stretching)	2011, 2017	Rolled or cold finished rod and bar
T4510	Solution heat treated*, stretched a controlled amount for stress relief, and naturally aged (no further straightening after stretching)	6061, 6066,	Extruded tube, wire, rod, bar, and profiles
T4511	Same as T4510 except minor straightening allowed after stretching to comply with standard tolerances	6061, 6066	Extruded tube, wire, rod, bar, and profiles
T5	Cooled from an elevated temperature shaping process and then artificially aged	6063, 6005, 6005A, 6105, 6162, 6351, 6463	Extruded tube, wire, rod, bar, and profiles
T51	Cooled from an elevated temperature shaping process and then artificially aged in underaging conditions to improve formability	6061, 6351	Extruded tube, (6061 only); extruded wire, rod, bar, and profiles
T52	Cooled from an elevated temperature shaping process and then artificially aged to specified minimum and maximum strength levels	6063	Extruded wire, rod, bar, and profiles
T6	Solution heat treated* and then artificially aged	All (with exceptions)	All (with exceptions)
T61	Solution heat treated* and then artificially aged in underaging conditions to improve formability	2018	Forgings and forging stock
T62	Solution heat treated in a furnace from annealed or F temper and artificially aged to demonstrate response to heat treatment	All	All
T63, T64, T65	Solution heat treated* and artificially aged to specified mechanical properties below T6	6101	Electrical conductor products as extruded tube, pipe, rolled or extruded structural profiles, and extruded wire, rod, bar, and profiles
T651	Solution heat treated*, stretched a controlled amount (product dependent) for stress relief, and artificially aged (no further straightening after stretching)	2014, Alclad 2014, 6061, Alclad 6061, 6262, 7075, Alclad 7075, 7178, Alclad 7178, 7475, Alclad 7475	Plate (most with exceptions), rolled or cold-finished rod and bar (most with exceptions)
T6510	Solution heat treated*, stretched a controlled amount (product dependent) for stress relief, and artificially aged (no further straightening after stretching	2014, 6061, 6066, 6162, 6262, 7075, 7178	Extruded tube (except for 6162 and 7178), wire, rod, bar, and profiles
T6511	Same as T6510 except minor straightening allowed after stretching to comply with standard tolerances	2014, 6061, 6066, 6162, 6262, 7075, 7178	Extruded tube (except for 6162 and 7178), wire, rod, bar, and profiles
T652	Solution heat treated*, compressed to a permanent set of 1-5% for stress relief, and artificially aged	2014, 6061, 6151, 7075	Forgings and forging stock
T7	Solution heat treated* and artificially overaged/stabilized to control important properties (rarely used without second digit as below)	7050	Rivets
T72	Solution heat treated* and artificially aged by user from O or F temper (not available from producer)	2024	Sheet
T73	Solution heat treated*, fully overaged artificially to achieve best corrosion resistance with a greater reduction in strength than T74	7049, 7075, Alclad 7075,	Sheet (7075 and Alclad 7075); drawn and extruded tube (7075); extruded wire, rod, bar, and profiles (7075); rolled or cold-finished rod, bar, and wire (7075); rivets (7075); forgings and forging stock (7049 and 7075)

Temper	Designation	T Temper Alloy	Product Forms
T72	Solution heat treated* and artificially aged by user from O or F temper (not available from producer)	2024	Sheet
T73	Solution heat treated*, fully overaged artificially to achieve best corrosion resistance with a greater reduction in strength than T74	7049, 7075, Alclad 7075,	Sheet (7075 and Alclad 7075); drawn and extruded tube (7075); extruded wire, rod, bar, and profiles (7075); rolled or cold-finished rod, bar, and wire (7075); rivets (7075); forgings and forging stock (7049 and 7075)
T7351	Solution heat treated*, stretched a controlled amount (product dependent) for stress relief, and artificially overaged to achieve best corrosion resistance with a greater reduction in strength than T74 (no further straightening after stretching)	7075, Alclad 7075	Plate (7075 and Alclad 7075), rolled or cold-finished rod and bar (7075)
T73510	Solution heat treated*, stretched a controlled amount (product dependent) for stress relief, and artificially overaged to achieve best corrosion resistance with a greater reduction in strength than T74 (no further straightening after stretching)	7050, 7075	Extruded wire, rod, bar, and profiles
T73511	Same as T73510 except minor straightening allowed after stretching to comply with standard tolerances	7050, 7075	Extruded wire, rod, bar, and profiles
T7352	Solution heat treated*, compressed to a permanent set of 1-5% for stress relief, and artificially overaged to achieve best corrosion resistance with a greater reduction in strength than T74	7049, 7075	Forgings and forging stock
T74**	Solution heat treated* and then artificially overaged to achieve corrosion resistance and strength level between the T73 and T76 tempers	7050	Forgings and forging stock
T7451**	Solutions heat treated*, stretched a controlled amount for stress relief (product dependent), and then artificially overaged to achieve corrosion resistance and strength level between the T73 and T76 tempers (no further straightening after stretching)	7050	Plate
T74510**	Solution heat treated*, stretched a controlled amount (product dependent) for stress relief, and artificially overaged to achieve corrosion resistance and strength level between the T73 and T76 tempers (no further straightening after stretching)	7050	Extruded wire, rod, bar, and profiles
T74511**	Same as T74510 except minor straightening allowed after stretching to comply with standard tolerances	7050	Extruded wire, rod, bar, and profiles
T7452**	Solution heat treated*, compressed to a permanent set of 1-5% for stress relief, and artificially overaged to achieve corrosion resistance and strength level between the T73 and T76 tempers	7050	Forgings and forging stock
T7454**	Solution heat treated*, stress relieved by restriking cold in finished die, and artificially overaging to achieve corrosion resistance and strength level between the T73 and T76 tempers	7175	
T76	Solution heat treated*, limited overaging to achieve moderate corrosion resistance with some reduction in strength relative to the T79 temper	7075, Alclad 7075, 7178, Alclad 7178, 7475	Sheet; drawn and extruded tube (7075), extruded wire, rod, bar, and profiles (7075 and 7178)
T7651	Solution heat treated*, stretched a controlled amount for stress relief (product dependent), and artificially overaged to achieve moderate corrosion resistance with some reduction in strength relative to the T79 temper (no further straightening after stretching)	7050, 7075, Alclad 7075, 7178, Alclad 7178, 7475, Alclad 7475	Plate
T76510	Solution heat treated*, stretched a controlled amount (product dependent) for stress relief, and artificially overaged to achieve moderate corrosion resistance with some reduction in strength relative to the T79 temper (no further straightening after stretching)	7050, 7075, 7178	Extruded wire, rod, bar, and profiles
T76511	Same as T76510 except minor straightening allowed after stretching to comply with standard tolerances	7050, 7075, 7178	Extruded wire, rod, bar, and profiles
T79	Solution heat treated* with slight overaging to achieve some improved corrosion resistance with slight reduction in strength relative to the T6 temper	No alloy-temper-product standardized	No alloy-temper-product standardized
T8	Solution heat treated*, cold worked, and then artificially aged	2011	Drawn tube, rolled or cold-finished rod, bar, and wire
T81	Solution heat treated*, cold worked ~1%, and then artificially aged	2024, Alclad 2024, 2219, Alclad 2219	Sheet, Extruded tube, wire, rod, bar, and profiles
T851	Solution heat treated*, stretched a controlled amount for stress relief (product dependent), and then artificially aged (no further straightening after stretching)	2024, Alclad 2024, 2219, Alclad 2219	Plate, rolled or cold-finished rod and bar (2024 and 2219)
T8510	Solution heat treated*, stretched a controlled amount (product dependent) for stress relief, and then artificially aged (no further straightening after stretching)	2024	Extruded tube, wire, rod, bar, and profiles
T8511	Same as T8510 except minor straightening allowed after stretching to comply with standard tolerances	2024	Extruded tube, wire, rod, bar, and profiles
T9	Solution heat treated*, artificially aged, and then cold worked	All	All
T10	Cooled from an elevated temperature shaping process, cold worked, and then artificially aged	All	All

*Solution heat treatment involves heating the product to a solutionizing temperature, holding at temperature long enough to allow constituents to enter into solid solution and cooling rapidly enough to hold constituents in solution. Some 6xxx and 7xxx series alloys attain the same specified mechanical properties whether furnace solution heat treated or cooled from an elevated temperature shaping process (such as extrusion or forging) at a rate rapid enough to hold constituents in solid solution. In such cases, temper designations T3, T4, T6, T7, T8, and T9 apply to either process and are appropriate designations.
**T74 tempers, although not previously registered have appeared in various literature and specifications as T736 tempers.

Table V. ANSI H35.1 temper designations and definitions used in the U.S., Europe through the EN 515 European standard, and internationally through the ISO 2107 standard for thermally treated (T temper) aluminum alloys and their products.

U.S.	CEN/ISO		Germany			France*	UK*	India*	Norway*
ANSI H35.1/H35.1(M)	EN 515/ ISO 2107	ISO*	DIN* 17007	DIN* 1712 1725	WL*	NF	BS	BIS	NS
F	F	M,F	--	Fxx	.0	--	M	M	00
F (hot rolled)	F	--	.07	Fxx	.0	X400	M	M	07
F (extruded)	F	O	.08	Fxx	.0	X300	M	M	08
F (forged)	F	O	.08	Fxx	.0	X100/200	M	M	08
O	O	O	.10	Wxx	.1	Xx10	O	O	02
W	W	W	--	--	--	--	--	--	--
T1	T1	TA	--	--	--	--	--	--	51
T2	T2	TC	--	--	--	--	--	--	52
T3	T3	TD	.51	Fxx	.6	--	TD	WD	53
T4	T4	TB	.41	Fxx	.4, .5	Xx40,Xx46	TB	W	54
T5	T5	TE	.61, .71	Fxx	.7	Xx30	TE	P	55
T6	T6	TF	.61,.62,.71,.72	Fxx	.7	Xx36	TF	WP	56
T7	T7	TM	--	--	.9	--	--	WS	--
T8	T8	TH	.73	Fxx	--	--	TH	WDP	58
T9	T9	TL	--	--	--	--	--	WPD	59
T10	--	TG	--	--	--	--	--	--	57

*ISO – old designations, replaced by ISO 2107 temper designation system.
*DIN 17007 (Germany) – old designations, replaced by EN 515 temper designation system.
*DIN 1712-2 and 1725-1 (Germany and German speaking countries) – old designations, replaced by EN 515 temper designation system. Thermally treated aluminum alloy tempers are indicated by a capital letter F followed by two numbers indicating 1/10 of the minimum tensile strength in N/mm^2 (rounded), e.g., AlMgSi1 F30 (old designation for alloy and temper) indicates a 6082 alloy heat treated to a minimum tensile strength of 295 N/mm^2 (42,775 psi) or equivalent to the strength level of a T6 temper.
*WL (Germany) – old designations formerly based on the German aerospace standard from the Werkstoffblätter der Deutschen Luftfahrt, replaced by EN 515 temper designation system.
*France – old designations, replaced by EN 515 temper designation system; "X" indicates type of semi-finished product: 1 = hand forging, 2 = drop forging, 3 = extruded profile, 4 = hot rolled sheet or strip, 5 = cold rolled sheet or strip, 6 = drawn products except wire, 7 = drawn wire.
*UK – old designations, replaced by EN 515 temper designation system.
*India – old designations, replaced by ISO 2107 temper designation system.
*Norway – old designations, replaced by ISO 2107 temper designation system.

Table VI. Comparison of temper designations used in the U.S., CEN member European countries, ISO participant countries (15 countries), and different or older temper standards for thermally treated aluminum alloys.

Correlation of New and Old Temper Designations for Wrought Thermally Treated Aluminum Alloys

Some of the old designations for wrought thermally treated aluminum alloys can be correlated with the new ANSI/EN/ISO designations as presented in Table VI. These older designations for aluminum alloys appear in literature dating back to the late 1980s, for example, the German DIN temper designations (now outdated and replaced by EN 515 designations) are used in the 1988 version of Aluminium-Taschenbuch, published in German.[7] The new 1999 version of this handbook, published in English, employs the EN 515 temper designations.[8]

Editor's Note: For more information on aluminum standards and data, go to the Aluminum Association website: www.aluminum.org.

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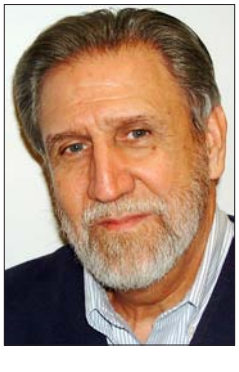

Joseph C. Benedyk (Dr. Joe) is a research professor at the Illinois Institute of Technology (IIT) working to establish cooperative industry/university research programs in the fields of heat treatment, casting, and extrusion of aluminum and aluminum alloys. Dr. Joe has contributed many articles to Light Metal Age *and serves as editor covering applications and technology of light metals.*