Non-Heat Treatable Alloys

-F As fabricated. Applies to the products of shaping processes in which no special control over thermal conditions or strain hardening is employed.

-O Annealed. Applies to wrought products which are fully annealed to obtain the lowest strength condition.

-H Strain hardened. Applies where the strength is increased by strain hardening, with or without supplementary thermal treatments to produce some reduction in strength.

The H is always followed by two or more digits. The first digit following the H indicates the specific combination of operations, as follows:

-H1 strain hardened only
-H2 strain hardened and partially annealed
-H3 strain hardened and stabilized

The second digit indicates the temper, as follows:

2 ¼ hard
4 ½ hard
6 ¾ hard
8 fullhard
9 extrahard

Added digits indicate modifications of standard practice.

Heat Treatable Alloys

-F As fabricated. Applies to the products of shaping processes in which no special control over thermal conditions or strain hardening is employed.

-O Annealed. Applies to wrought products which are fully annealed to obtain the lowest strength condition.

-W Solution heat treated. An unstable temper applicable only to alloys which spontaneously age at room temperature, after solution heat treatment this designation is specific only when the period of natural aging is indicated.

-T Thermally treated to produce stable tempers other than F, O, or H.

The T is always followed by one or more digits. Numeral 1 through 10 following the T indicate specific sequences of basic treatments, as follows:

-T1 Cooled from an elevated temperature shaping process and naturally aged to a substantially stable condition.
-T2 Annealed to improve ductility and dimensional stability.
-T3 Solution heat treated and then cold worked.
-T4 Solution heat treated and naturally aged to a substantially stable condition.
-T5 Cooled from elevated temperature shaping process and then artificially aged.
-T6 Solution heat treated and then artificially aged.
-T7 Solution heat treated and then stabilized.
-T8 Solution heat treated, cold worked, and then artificially aged.
-T9 Solution heat treated, artificially aged, and then cold worked.
-T10 Cooled from an elevated temperature shaping process, artificially aged and then cold worked.

Additional digits are used to designate stress relieving:

-T51 Stress relieving by stretching.
-T52 Stress relieving by compressing,

T510 designates products that receive no further straightening after stretching, and T511 designates products that receive minor straightening in order to comply with standard tolerances.

612 East Franklin Avenue, P.O. Box 2425, El Segundo, California 90245-4111 U.S.A.
ph 310.640.8444 • fax 310.640.2247 • e-mail olympic@ctcoa.com • website www.ctcoa.com

olympic aviation

Even though many of the aluminum alloys are not standardly produced to all tempers, we can, in many cases, provide such tempers by having a specific material heat treated in conformance with a particular specification and then tested by a certified testing laboratory in order to provide the appropriate certification. Note, however, that some tempers produced by the manufacturer cannot be heat treated to some other specific tempers. For example, 2024 aluminum is generally produced as 2024-T4 for sizes ⅝" diameter and smaller, and 2024-T351 for sizes ¾" diameter and larger. As such, bars ¾" diameter and larger can be heat treated to temper "T-8" to provide 2024-T851, but bars ⅝" diameter and smaller cannot be heat treated to temper "T-8" as they have not been cold worked by the manufacturer and thus lack the necessary tensile strength to reach "T-8" requirements after artificial aging.

Aluminum alloys are commonly produced to federal specification (QQ-A-225, QQ-A-250, WW-T-700, etc.), AMS specification (AMS 4120, AMS 4027, etc.), and ASTM specification (ASTM-B-209, ASTM-B-211, etc.). These specifications provide the chemical and physical requirements, as well as other testing and dimensional tolerance information. Each year the Aluminum Association publishes the "Aluminum Standards and Data" which is an invaluable source of information concerning all aspects of the American industry's production procedures. Among the topics of particular interest addressed in this publication is that concerning visual inspection of aluminum mill products. This section, which applies to the possible rejection of sheets, as well as bars, tubes, and extrusion is provided below.

The following criteria are generally recognized as applicable for visual inspection for discontinuities in aluminum mill products, and parts manufactured from these products, with or without the aid of liquid penetrant methods (Liquid penetrant methods of inspection should not be used in lieu of pressure tests when material or parts are used in applications requiring pressure and/or leak tightness unless such substitution is negotiated between purchaser and vendor. If penetrant inspection is used in lieu of pressure testing, the acceptance or rejection of material or parts shall be judged on the basis of the ability of representative material to withstand an applicable pressure or leak test). It is generally recognized that the various liquid penetrant methods of inspection of metal products for surface discontinuities are useful aids to visual inspection. However, it should be recognized also that these inspection methods frequently develop extraneous indications that are not indicative of defective material or parts.

1- *Any discontinuity that can be completely removed with reasonable facility, within the applicable dimensional tolerances for the material or part being inspected, is not considered as reason for rejection of the part or material unless the removal of the discontinuity makes the surface unsuitable for applications where surface appearance is important and where surface considerations were made known to the seller at the time the order was placed.*

2- *Verifiable indications of the following discontinuities that cannot be completely removed with reasonable facility, within the applicable dimensional tolerances for the material or part being inspected, are considered reason for rejection regardless of the use to which the material or part is being put:*

a – Cracks	*c – Seam defects*
b – Laps	*d – Flow through (forgings)*

3- *Verifiable indications of the following discontinuities that cannot be completely removed with reasonable facility, within the applicable dimensional tolerances for the material or parts being inspected, may be considered as reason for rejection of the material or part subject to mutual agreement between the purchaser and vendor with due consideration being given to the alloy and application of the part or material.*

a – Blisters	*i – Voids resulting from selective etch attack*
b – Silvers	*j – Metal Pickup*
c – Cold shuts	*k – Fins*
d – Inclusions	*l – Pin holes*
e – Scratches	*m – Die lines*
f – Gouges	*n – Abrasions*
g – Nicks	*o – Streaks*
h – Corrosion	*p – Non uniform surface appearance (See "Water Stain," "Oil Stain," "Heat Treat Stain," and "Oxide Discoloration"*

612 East Franklin Avenue, P.O. Box 2425, El Segundo, California 90245-4111 U.S.A.
ph 310.640.8444 • fax 310.640.2247 • e-mail olympic@ctcoa.com • website www.ctcoa.com