



## Aluminum Alloy Designation

The first digit designates the major alloy	Description of Alloy
<b>1xxx</b> Series designates alloy free (no alloys) and is at least 99% aluminum.	Aluminum of 99 percent or higher purity has many applications, especially in the electrical and chemical fields. These compositions are characterized by excellent corrosion resistance, high thermal and electrical conductivity, low mechanical properties and excellent workability. Moderate increases in strength may be obtained by strain hardening. Iron and silicon are the major impurities.
<b>2xxx</b> Series designates copper as the major alloy (1.9%...6.8%)	Copper is the principal alloying element in this group. These alloys require solution heat treatment to obtain optimum properties; in the heat treated condition mechanical properties are similar to, and sometimes exceed, those of mild steel. In some instances artificial aging is employed to further increase the mechanical properties. This treatment materially increases yield strength, with attendant loss in elongation; its effort on the tensile (ultimate) strength is not so great. The alloys in the 2xxx series do not have as good corrosion resistance as most other aluminum alloys, and under certain conditions they may be subject to intergranular corrosion. Therefore, these alloys in the form of sheet are usually clad with a high purity alloy or a magnesium-silicon alloy of the 6xxx series, which provides galvanic protection to the core material thus greatly increases resistance to corrosion. Alloy 2024 is perhaps the best known and most widely used aircraft alloy.
<b>3xxx</b> Series designates manganese as the major alloy (0.3%...1.5%)	Manganese is the major alloying element of alloys in this group, which are generally non-heat-treatable. Because only a limited percentage of manganese, up to about 1.5 percent, can be effectively added to the aluminum, it is used as a major element in only a few instances. One of these, however is the popular 3003, which is widely used as a general purpose alloy for moderate strength applications requiring good workability.
<b>4xxx</b> Series designates silicon as the major alloy (3.6%...13.5%)	The major alloying element of this group is silicon, which can be added in sufficient quantities to cause substantial lowering of the melting point without producing brittleness in the resulting alloys. For these reasons aluminum silicon alloys are used in welding wire and as brazing alloys where a lower melting point of the parent metal is required. Most alloys in this series are non-heat-treatable, but when used in welding heat treatable alloys they will pick up some of the alloying constituents of the latter and so respond to heat treatment to a limited extent. The alloys containing appreciable amounts of silicon become dark gray when anodic oxide finishes are applied, and hence are in demand for architectural applications.
<b>5xxx</b> Series designates magnesium as the major alloy (0.5%...5.5%)	Magnesium is one of the most effective and widely used alloying elements for aluminum. When it is used as the major alloying element of manganese, the result is a moderate to high strength non-heat-treatable alloy. Magnesium is considerably more effective than manganese as a hardener, about 0.8 percent magnesium being equal to 1.25 percent manganese, and it can be added in considerably higher quantities. Alloys in this series possess good welding characteristics and good resistance to corrosion in marine atmosphere. However, certain limitations should be placed on the amount of cold work and on the safe operating temperatures permissible for the higher magnesium content alloys (over about 3.5 percent for operating temperatures about 150F) to avoid susceptibility to stress corrosion.
<b>6xxx</b> Series designates magnesium and silicon as the major alloys (Mg 0.4%...1.5%, Si 0.2%...1.7%)	Alloys in this group contain silicon and magnesium in approximate proportions to form magnesium silicide, thus making them heat treatable. The major alloy in this series is 6061, one of the most versatile of the heat treatable alloys. Though less strong than most of the 2xxx or the 7xxx alloys, the magnesium silicon alloys possess good formability and corrosion resistance, with medium strength. Alloys in this heat treatable group may be formed in the t4 temper and then reach full t6 properties by artificial aging.
<b>7xxx</b> Series designates zinc as the major alloy (1%...8.2%)	Zinc is the major alloying element in this group, and when coupled with a smaller percentage of magnesium results in heat treatable alloys of very high strength. Usually other elements such as copper and chromium are also added in small quantities. The outstanding member of this group is 7075, which is among the highest strength alloys available and is used in air-frame structures and for highly stressed parts.

**The second digit designates the purity of the aluminum and mill control**

Original (basic) alloy is designated by "0" as the second digit. Numbers 1...9 indicate various alloy modifications with slight differences in the compositions. In the alloys of the 1xxx series the second digit indicates modifications in impurity limits: 0 means natural impurity limit, 1...9 indicate special control of one or more impurities or alloying element.

**The third and fourth digits identify aluminum alloy or indicate the alloy purity**

If the aluminum is 1xxx then the last two digits designate the amount of aluminum above 99%. For example 1025 signifies a non alloyed aluminum that is 99.25% pure aluminum with the remaining 0.75% uncontrolled impurities. In all other groups of aluminum alloys (2xxx through 7xxx) the last two digits signify different alloys in the group.

**Temperature Designations**

The basic temper designations consist of a letter followed by one or more numbers. When the temper is written with the alloy designation the combination gives a complete description of the metal. For example, 3003-H16 is the alloy 3003 with temper H16.

The various temper designations are as follows:

**F Temper**

Fabricated with no control-employed properties.

**O Temper**

Applies to metal annealed to give the lowest possible strength.

**H Temper**

Applies to metal that has been strain hardened with maybe some additional annealing. The H is always followed by two or more numbers.

**T Temper**

Applies to metal that has been thermally treated with some additional strain hardening. The T is always followed by one or more numbers.

The H tempers are divided into 3 subdivisions: H1, H2, and H3

**H1**

Strain hardened only. Strain hardening means cold work.

**H2**

Strain hardened and partially annealed.

**H3**

Strain hardened and stabilized. This only applies to those alloys which would soften at room temperature unless stabilized with an additional heat treatment.

The H tempers are always followed by one or more numbers. The second digit represents a number scale designation ranging from 0 through 8, with 8 being the hardest and 0 being the fully annealed, or softest temper.

Therefore, the product 3003-H16 previously mentioned is a manganese based alloy (3003) that has been strained hardened only (H1) to a three-quarter hard temper (6).

The T designations are used to indicate stable tempers achieved by heat treating. The T is always followed by one or more digits, i.e., TXY. In this case, the X is a number from 2 through 10 and each represents a specific sequence of manufacturing operations. The second digit, Y, represents different end properties only and does not indicate any special set of conditions. Fabricators will not normally encounter T designations.

**Anodizing**

Anodizing is a method for accelerating the format of a hard oxide film on the aluminum surface by enveloping the metal in an electrolytic bath. The oxide film can be made clear and hard or colored with organic on inorganic colorings. In either finish, the natural metallic brilliance of the aluminum is retained.

**Cladding**

There are aluminum alloys that are susceptible to corrosion. The 2xxx series containing copper is especially sensitive to environment. The copper and aluminum have different galvanic potentials which create electrical corrosions within the metal. One method too avoid this corrosion is to clad the base material with a more pure alloy. This is done at the rolling mills where a layer of more pure aluminum is rolled onto the surface of the base metal, thus providing maximum surface protection with high core strength.

**Welding**

The hard heat treatable alloys, 2xxx, 6xxx, and 7xxx, can be welded by resistance welding. The common alloys, 1xxx, 3xxx, 4xxx, and 5xxx, are easily welded by fusion. TIG (tungsten inert gas) or MIG (metal inert gas) are good methods for fusion welding. There are several factors which must be considered when welding aluminum. One of the more important factors is the hard oxide film which must be removed before a good weld is possible. The film can be removed by cleaning with a stainless steel brush or chemical cleaning. Because aluminum melts at a low temperature, the temperature must be measured by physical conditions rather than appearances. There will be no color even at temperatures up to the melting point. The low strength of aluminum at high temperatures means that the part must be well supported to prevent distortions or collapse. This brief summary of aluminum alloys, their designations, tempers, and uses has been provided as an overview of a large amount of data. Your local metal supply house can provide you with data books on everyday types of aluminum alloys and shaped carried in stock. These books will also provide additional technical data and designations on weldability, resistance to corrosions, definitions, weights of shapes, and chemical composition.

The temper designation scheme is shown in the figure below.

