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MILITARY HANDBOOK

ALLOY AND TEMPER DESIGNATION

SYSTEM FOR MAGNESIUM BASE ALLOYS

AMSC N/A

FSC 96GP

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DEPARTMENT OF DEFENSE
Washington, D. C. 20301

Alloy Nomenclature and Temper Designation
System for Magnesium Base Alloys
MIL-STD-409A

1. This Military Standard is mandatory for use by all Departments and Agencies of the Department of Defense, effective 5 December 1966. This revision supersedes MIL-STD-409 dated 14 February 1957.

2. Recommended corrections, additions, or deletions should be addressed to the Air Force Materials Laboratory, Attn: MAAS, Wright-Patterson Air Force Base, Ohio 45433.

FOREWORD

1. The alloy nomenclature and temper designation system for magnesium base alloys described herein was devised by the American Society for Testing and Materials and officially adopted by The Magnesium Association.

2. This document serves to standardize the alloy nomenclature and temper designation for magnesium base alloys throughout the magnesium industry and the Department of Defense.

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TABLES

MILITARY STANDARD

ALLOY NOMENCLATURE AND TEMPER DESIGNATION SYSTEM FOR MAGNESIUM BASE ALLOYS

1. SCOPE

1.1 This standard establishes a uniform system for designating the alloying elements, the respective percentages of these elements, the serial letters, and the temper designations for magnesium base alloys.

2. REFERENCED DOCUMENTS

2.1 Not applicable.

3. DEFINITIONS

3.1 Alloying element. For codification, an alloying element is defined as an element (other than the base metal) having a minimum content greater than zero either directly specified or computed in accordance with the percentages specified for other elements. The amount present is the mean of the range (or the minimum percentage if only that is specified) before rounding off.

4. ALLOY NOMENCLATURE

4.1 Alloying elements. The designations used for alloys shall consist of not more than two letters representing the alloying element (see 3.1). The letters used to represent the alloying elements shall be those specified in table I. The alloying elements shall be those specified in the greatest amount and shall be arranged in order of decreasing percentages or in alphabetical order if of equal percentages.

Table I. Letters representing alloy elements

A--Aluminum	E--Rare earths	L--Lithium	Q--Silver	Y--Antimony
B--Bismuth	F--Iron	M--Manganese	R--Chromium	Z--Zinc
C--Copper	H--Thorium	N--Nickel	S--Silicon	
D--Cadmium	K--Zirconium	P--Lead	T--Tin	

4.2 Percentage of alloying elements. The two letters representing the alloying elements shall be immediately followed by the elements respective percentages rounded off to whole numbers. In rounding off percentages to whole numbers, the nearest whole number shall be chosen. If two choices are possible, as when the digits dropped are exactly a 5 or a 5 followed only by 0's, the number ending in an even digit shall be chosen.

4.2.1 When a range is specified for the alloying element, the rounded-off mean shall be used in the designation.

4.2.2 When only a minimum percentage is specified for the alloying element, the rounded-off minimum percentage shall be used in the designation.

4.3 Serial letter. The alloying elements and their respective percentages shall be immediately followed by a serial letter. The serial letter shall be arbitrarily assigned in alphabetical sequence starting with A (omitting I and O) and shall serve to differentiate otherwise identical designations. A serial letter shall be necessary to complete each designation. If the composition is not exactly equivalent to one listed in the ASTM Magnesium Association list, the alloy designation shall be shown without a serial letter.

4.4 Casting ingots. The designation of a casting alloy in ingot form shall be derived from the composition specified for the corresponding alloy in the form of castings. Thus, a casting ingot designation may consist of an alloy designation having one or more serial letters, one for each product composition, or it may consist of one or more alloy designations.

5. UNALLOYED METALS

5.1 Designations for unalloyed metals shall consist of the specified minimum purity, all digits retained but dropping the decimal point, followed by a serial letter. The serial letter shall be arbitrarily assigned in alphabetical sequence starting with A (omitting I and O) and shall serve to differentiate otherwise identical designations. A serial letter shall be necessary to complete each designation. The full name of the base metal shall precede the designation, but it may be omitted for brevity when the base metal being referred to is obvious.

6. GRANULAR METAL PRODUCTS

6.1 Designation of light metals and alloys formed as a wrought product from granular metal powders or granules shall be by use of the prefix (P) in parentheses to the letter or letters forming the alloy designation.

7. TEMPER DESIGNATION

7.1 The temper designation, that is used for all metal forms except ingot, shall follow the alloy designation and shall be separated therefrom by a dash.

7.2 The designation for temper shall be based on the sequence of basic treatments used to produce the temper. The basic temper designation shall consist of letters. Subdivisions of the basic temper, where required, shall be indicated by one or more digits following the letter. These digits shall designate a specific sequence of basic treatments, but only those operations that are recognized as significantly influencing the characteristics of the product shall be indicated. Should some other variation of the same sequence of the basic operation be applied to the same alloy, resulting in different characteristics, then additional digits shall be added to the designation.

7.3 The temper designations and the subdivisions shall be as defined in table II. A brief outline for quick reference is given in table III.

Table II. Temper designations

F...As fabricated. This designation shall apply to products that acquire some temper from shaping processes not having special control over the amount of strain hardening or thermal treatment.

O...Annealed recrystallized (wrought products only). This designation shall apply to the softest temper of wrought alloy products.

H...Strain hardened. This designation shall apply to those products that have their strength increased by strain hardening with or without supplementary thermal treatments to produce partial softening. The H shall always be followed by two or more digits. The first digit shall indicate the specific combination of basic operations, and the following digit or digits the final degree of strain hardening.

Subdivisions of the H temper:

H1...Strain hardened only. This designation shall apply to products that are strain hardened to obtain the desired mechanical properties without supplementary thermal treatment. The number following this designation shall indicate the degree of strain hardening.

H2...Strain hardened and then partially annealed. This designation shall apply to products that are strain hardened more than the desired final amount and then reduced in strength to the desired level by partial annealing. For alloys that age soften at room temperature, the H2 tempers have approximately the same tensile strength as the corresponding H3 tempers. For other alloys, the H2 tempers have approximately the same tensile strength as the corresponding H1 tempers and slightly

Table II. Temper designations (continued)

higher elongations. The number following this designation shall indicate the degree of strain hardening remaining after the product has been partially annealed.

H3...Strain hardened and then stabilized. This designation shall apply to products that are strain hardened and then stabilized by a low temperature heating to slightly lower their strength and increase ductility. This designation shall apply only to those alloys that, unless stabilized, age soften at room temperature. The number following this designation shall indicate the degree of strain hardening remaining after the product has been strain hardened a specific amount and then stabilized.

Subdivisions of the H1, H2, and H3 tempers: The number following these designations shall indicate the final degree of strain hardening. The hardest commercially practical temper shall be designated by the numeral 8 (full hard). Tempers between 0 (annealed) and 8 (full hard) shall be designated by numerals 1 through 7. Material having a strength about midway between that of the 0 temper and that of the 8 temper shall be designated by the numeral 4 (half hard), and that between 0 and 4 by the numeral 2 (quarter hard), and that between 4 and 8 by the numeral 6 (three-quarter hard). Numeral 9 shall designate extra hard tempers. The third digit, when used, shall indicate a variation of a two-digit H temper. It shall be used when the degree of control of temper or the mechanical properties are different from but close to those for the two-digit H temper to which it is added. Numerals 1 through 9 may be arbitrarily assigned for an alloy and product to indicate a specific degree of control of temper or specified mechanical property limits.

W...Solution heat treated. This is an unstable temper. It shall be applicable only to those alloys that spontaneously age at room temperature after solution heat treatment. This designation shall be specific only when the period of natural aging is indicated.

T...Thermally treated to produce stable tempers other than F, O, or H. This designation shall apply to products thermally treated, with or without supplementary strain hardening, to produce stable tempers. The T shall be followed by one or more digits.

Table II. Temper designations (continued)

Numerals 2 through 10 shall be assigned to each to indicate one specific sequence of treatments as follows:

Subdivisions of the T temper:

T2...Annealed (cast products only). This designation shall apply to castings only, to indicate a type of annealing operation used to improve ductility and increase dimensional stability.

T3...Solution heat treated and then cold worked. This designation shall apply to those products where cold work is performed for the primary purpose of improving the strength, and also shall apply to those products in which the effect of cold work (such as flattening or straightening) is recognized in applicable specifications.

T4...Solution heat treated and naturally aged to a substantially stable condition. This designation shall apply when the product is not cold worked after heat treatment, and also shall apply when applicable specifications may not recognize the effect of cold work in flattening and straightening operations.

T5...Artificially aged only. This designation shall apply to products artificially aged after an elevated-temperature, rapid-cool fabrication process, such as casting or extrusion, to improve mechanical properties and dimensional stability, or both.

T6...Solution heat treated and then artificially aged. This designation shall apply to products that are not cold worked after solution heat treatment, and in which the effect, if any, of flattening or straightening may not be recognized in applicable specifications.

T7...Solution heat treated and then stabilized. This designation shall apply to products in which the temperature and time conditions for stabilizing are such that the alloy is carried beyond the point of maximum hardness, providing control of growth and residual stress, or both.

T8...Solution heat treated, cold worked, and then artificially aged. This designation shall apply when the cold working is done for the purpose of improving strength, and also shall apply when the cold working effect of flattening or straightening is recognized in applicable specifications.

Table II. Temper designations (continued)

T9...Solution heat treated, artificially aged, and then cold worked. This designation shall apply when the cold working is done for the purpose of improving strength.

T10...Artificially aged and then cold worked. This designation shall apply to products artificially aged after an elevated-temperature, rapid-cool fabrication process, such as casting or extrusion, and then cold worked to improve strength.

A period of natural aging at room temperature may occur between or after the operations listed for tempers T3 through T10. Control of this period shall be exercised when it is metallurgically important.

Additional digits may be added to designations T2 through T10 to indicate a variation in treatment that significantly alters the characteristics of the product. These may be arbitrarily assigned for an alloy and product to indicate a specific treatment or specific mechanical properties.

Table III. Basic temper designations and subdivisions

F...As fabricated.

O...Annealed, recrystallized (wrought products only).

H...Strain hardened.

Subdivisions of the H temper:

H1, plus one or more digits...Strain hardened only.
H2, plus one or more digits...Strain hardened and then partially annealed.
H3, plus one or more digits...Strain hardened and then stabilized.

W...Solution heat treated. Unstable temper.

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

Subdivisions of the T temper:

T2...Annealed (cast products only).
T3...Solution heat treated and then cold worked.
T4...Solution heat treated.
T5...Artificially aged only.
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..Artificially aged and then cold worked.

Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.

Custodians:
Army - MR
Navy - AS
Air Force - 11

Reviewer activities:
Army - MI, MR, MU
Navy - AS
Air Force 11

User activities:
Army - AT, AV
Navy - AS, OS, SH, YD

Preparing activity:
Air Force - 11

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