SLOVENSKI STANDARD
SIST EN 515:1998

01-april-1998

Aluminij in aluminijeve zlitine - Gneteni izdelki - Označevanje stanj

Aluminium and aluminium alloys - Wrought products - Temper designations

Aluminium und Aluminiumlegierungen - Halbzeug - Bezeichnungen der Werkstoffzustände

Aluminium et alliages d'aluminium - Produits corroyés - Désignation des états métallurgiques

Ta slovenski standard je istoveten z: **EN 515:1993**

ICS:

77.150.10	Aluminijski izdelki	Aluminium products

SIST EN 515:1998 **en**

EUROPEAN STANDARD **EN 515**

NORME EUROPÉENNE

EUROPÄISCHE NORM August 1993

UDC 669.71:669.715.018.26:001.4

Descriptors: Aluminium, Aluminium alloys, rolled products, steel strips, wire rod, delivery condition, designation

English version

Aluminium and aluminium alloys - Wrought products - Temper designations

Aluminium et alliages d'aluminium - Produits corroyés - Désignation des états métallurgiques

Aluminium und Aluminiumlegierungen - Halbzeug - Bezeichnungen der Werkstoffzustände

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

The European Standards exist in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Contents list

Foreword

This European Standard has been drawn up by CEN/TC 132 "Aluminium and aluminium alloys", whose Secretariat is held by the Association Française de Normalisation (AFNOR), in liaison with AECMA (Association Européenne des Constructeurs de Matériel Aérospatial) Committee C5 "Metallic materials".

Within its programme of work, Technical Committee CEN/TC 132 entrusted CEN/TC 132/WG 7 "Sheets, strips and plates" to prepare the following standard :

EN 515 Aluminium and aluminium alloys - Wrought products - Temper designations.

CEN/TC 132 met on 19 and 20 March 1992 in Paris and agreed on the text to be submitted to CEN members for formal vote.

The result of the formal vote was positive.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 1994, and conflicting national standards shall be withdrawn at the latest by February 1994.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

1 Scope

This European Standard establishes temper designations for all forms of wrought aluminium and aluminium alloys and for continuously cast aluminium and aluminium alloy drawing stock and strip intended to be wrought.

NOTE : Some of these temper designations may be the subject of patent or patent applications, and their listing herein is not to be construed in any way as the granting of a license under such patent right.

Additional temper designations, conforming to this standard, may be standardized with CEN/TC132 and AECMA/C5 provided :

- the temper is used or is available for use by more than one user,

- mechanical property limits are defined,

- the characteristics of the temper are significantly different from those of all other tempers which have the same sequence of basic treatments and for which designations already have been assigned for the same alloy and product

- the following are also defined if characteristics other than mechanical properties are considered significant :

  - test methods and limits for the characteristics, or

  - the specific practices used to produce the temper.

2 Definitions

For the purposes of this standard the following definitions apply.

2.1 cold working : Plastic deformation of metal at such temperature and rate that strain-hardening occurs.

2.2 strain-hardening : Modification of a metal structure by cold working resulting in an increase in strength and hardness with loss of ductility.

2.3 solution heat-treating : A thermal treatment which consists of heating the products to a suitable temperature, holding at that temperature long enough to allow constituents to enter into solid solution and cooling rapidly enough to hold the constituents in solution.

2.4 ageing : Precipitation from supersaturated solid solution resulting in a change in properties of an alloy, usually occurring slowly at room temperature (natural ageing) and more rapidly at elevated temperatures (artificial ageing).

2.5 annealing : A thermal treatment to soften metal by removal of strain-hardening or by coalescing precipitates from solid solution.

3 Basis of codification

3.1 The temper designations are based on the sequences of basic treatments used to produce the various tempers. Property (mechanical or physical) limits apply to individual alloy-temper-product combinations.

3.2 The temper designation follows the alloy designation; these are separated by a hyphen.

3.3 Basic temper designations consist of letters. If subdivisions of the basic tempers are required, these are indicated by one or more digits following the letter of the basic temper. These digits relate to a specific sequence of basic treatments, but only those treatments or operations recognized as significantly influencing the product characteristics are indicated.

Should some other variation of the same sequence of basic operations be applied to the same alloy, resulting in different characteristics, then additional digits are added to the designation.

4 Basic temper designations

4.1 F - As fabricated

This designation applies to the products of shaping processes in which no special control over thermal conditions or strain-hardening is employed. For this temper, there are no mechanical property limits specified.

4.2 O - Annealed

This designation applies to products which are annealed to obtain the lowest strength temper. The O may be followed by a digit other than zero. [1)]

4.3 H - Strain-hardened

This designation applies to products subjected to the application of cold work after annealing (or after hot forming), or to a combination of cold work and partial annealing or stabilizing, in order to secure the specified mechanical properties. The letter H is always followed by at least two digits, the first indicating the type of thermal processing and the second indicating the degree of strain-hardening (a third digit is used in some cases to identify special processing techniques).

4.4 W - Solution heat-treated

This designation describes an unstable temper. It applies only to alloys which spontaneously age at room temperature after solution heat-treatment. This designation is specific only when the period of natural ageing is indicated; for example W 1/2h.

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

This designation applies to products which are thermally treated, with or without supplementary strain-hardening, to produce stable tempers. The T is always followed by one or more digits indicating the specific sequence of treatments.

5 Subdivisions of O (annealed) temper designations

5.1 O1 - High temperature annealed and slow cooled [2)]

This designation applies to wrought products which are thermally treated at approximately the same time and temperature required for solution heat-treatment and slow cooled to room temperature, in order to accentuate ultrasonic response and/or provide dimensional stability. It is applicable to products which are to be machined prior to solution heat treatment by the user. Mechanical property limits are not specified.

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1) Products achieving the required annealed properties after hot forming processes may be designated as O temper.

2) Formerly designated as T41.

5.2 O2 - Thermo-mechanically processed

This designation applies to wrought products subjected to a special thermo-mechanical treatment. It is applicable to products which are to be super-plastically formed prior to solution heat treatment by the user.

5.3 O3 - Homogenized

This designation applies to continuously cast drawing stock or strip which are subjected to a high temperature soaking treatment to eliminate or reduce segregations, thus improving subsequent formability and/or response to solution heat-treatment.

6 Subdivisions of H (strain-hardened) temper designations

Subdivisions are made according to the basic operations described in 3.3 and the final degree of strain hardening, as follows :

6.1 First digit after H

The first digit following the letter H indicates the specific combination of basic operations as follows :

- H1x Strain-hardened only

These designations apply to products which are strain-hardened to obtain the desired strength without supplementary thermal treatment.

- H2x Strain-hardened and partially annealed

These designations apply to products which 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 H2x tempers have the same minimum ultimate tensile strength as the corresponding H3x tempers. For other alloys, the H2x tempers have the same minimum ultimate tensile strength as the corresponding H1x tempers and slightly higher elongation.

- H3x Strain-hardened and stabilized

These designations apply to products which are strain-hardened and whose mechanical properties are stabilized either by a low temperature thermal treatment or as a result of heat introduced during fabrication. Stabilization usually improves ductility. This designation is applicable only to those alloys which, unless stabilized, gradually age-soften at room temperature.

- H4x Strain-hardened and lacquered or painted

These designations apply to products which are strain-hardened and which may be subjected to some partial annealing during the thermal curing which follows the painting or lacquering operation.

6.2 Second digit after H

The second digit following the letter H indicates the final degree of strain-hardening, as identified by the minimum value of the ultimate tensile strength.

- Numeral 8 has been assigned to the hardest tempers normally produced. The minimum tensile strength of tempers Hx8 may be determined from table 1 and is based on the minimum tensile strength of the alloy in the annealed temper.

Table 1

Minimum tensile strength in annealed temper MPa	Increase in tensile strength to Hx8 temper MPa
up to 40	55
45 to 60	65
65 to 80	75
85 to 100	85
105 to 120	90
125 to 160	95
165 to 200	100
205 to 240	105
245 to 280	110
285 to 320	115
325 and over	120

- Tempers between O (annealed) and Hx8 are designated by numerals 1 to 7.

  - Numeral 4 designates tempers whose ultimate tensile strength is approximately midway between that of the O temper and that of the Hx8 tempers;

  - Numeral 2 designates tempers whose ultimate tensile strength is approximately midway between that of the O temper and that of the Hx4 tempers;

  - Numeral 6 designates tempers whose ultimate tensile strength is approximately midway between that of the Hx4 tempers and that of the Hx8 tempers;

  - Numerals 1, 3, 5 and 7 designate, similarly, tempers intermediate between those defined above.

- Numeral 9 designates tempers whose minimum ultimate tensile strength exceeds that of the Hx8 tempers by 10 MPa or more.

- The ultimate tensile strength of intermediate tempers, determined as described above, when not ending in 0 or 5, shall be rounded to the next higher 0 or 5.

6.3 Third digit after H

The third digit, when used, indicates a variation of a two-digit temper. It is used when the degree of control of temper or the mechanical properties or both differ from, but are close to, that (or those) for the two-digit H temper designation to which it is added, or when some other characteristic is significantly affected.

The following three-digit H temper designations have been assigned:

- **Hx11** Applies to products which incur sufficient strain-hardening after the final anneal that they fail to qualify as annealed but not so much or so consistent an amount of strain-hardening that they qualify as Hx1.

- **H112** Applies to products which may acquire some temper from working at an elevated temperature or from a limited amount of cold work, and for which there are mechanical property limits.

- **H116** Applies to products, made of those alloys of the 5xxx group in which the magnesium content is 4 % or more, and for which there are mechanical property limits and a specified resistance to exfoliation corrosion.

- **Hxx4** Apply to patterned or embossed sheet and strip fabricated from the corresponding Hxx temper.

EXAMPLE : an embossed sheet fabricated from an H42 temper is designated H424;

H114 applies to products fabricated from O, Hx1, H111 or H112 tempers.

The mechanical properties of the specified temper may deviate (after embossing or engraving) from those of the original temper.

- **Hxx5** Apply to welded tube. Depending on alloy and geometry of the tube, the mechanical property limits may differ from those of the corresponding Hxx temper for strip.

6.4 Other digits after H

If necessary, other or additional digits may be used to identify other variations of a subdivision of basic temper H. Such additional identification will be allocated to specific alloys as the need arises.

7 Subdivisions of T (thermally treated to produce tempers other than F, O or H) temper designations

7.1 First digit after T

The first digit following the letter T is used to identify the specific sequences of basic treatments. Numerals 1 to 9 have been assigned as follows: [3]

- **T1** **Cooled from an elevated temperature shaping process and naturally aged to a substantially stable condition**

This designation applies to products which are not cold worked after cooling from an elevated temperature shaping process, or in which the effect of cold work in flattening or straightening may not be recognized in mechanical property limits.

- **T2** **Cooled from an elevated temperature shaping process, cold worked and naturally aged to a substantially stable condition**

This designation applies to products which are cold worked to improve strength after cooling from an elevated temperature shaping process, or in which the effect of cold work in flattening or straightening is recognized in mechanical property limits.

- **T3** **Solution heat-treated [4], cold worked and naturally aged to a substantially stable condition**

This designation applies to products which are cold worked to improve strength after solution heat-treatment, or in which the effect of cold work in flattening or straightening is recognized in mechanical property limits.

- **T4** **Solution heat-treated [4] and naturally aged to a substantially stable condition**

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[3] A period of natural ageing at room temperature may occur between or after the operations listed for the T tempers. Control of this period is exercised when it is metallurgically important.

[4] Some 6000 or 7000 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 designation applies to products which are not cold worked after solution heat-treatment, or in which the effect of cold work in flattening or straightening may not be recognized in mechanical property limits.

- T5 Cooled from an elevated temperature shaping process and then artificially aged

This designation applies to products which are not cold worked after cooling from an elevated temperature shaping process, or in which the effect of cold work in flattening or straightening may not be recognized in mechanical property limits.

- T6 Solution heat-treated [4] and then artificially aged

This designation applies to products which are not cold worked after solution heat-treatment, or in which the effect of cold work in flattening or straightening may not be recognized in mechanical property limits.

- T7 Solution heat-treated [4] and overaged/stabilized

This designation applies to products which are artificially aged after solution heat-treatment to carry
them beyond a point of maximum strength to provide control of some significant characteristic other than mechanical properties. [5]

- T8 Solution heat-treated [4], cold worked and then artificially aged

This designation applies to products which are cold worked to improve strength, or in which the effect of cold work in flattening or straightening is recognized in mechanical property limits.

- T9 Solution heat-treated [4], artificially aged and then cold worked

This designation applies to products which are cold worked to improve strength.

The above definitions are summarized in table 2.

4) See page 8

5) The test method and limit used to evaluate material to this characteristic are specified at the time of the temper definition.