DRAFT INTERNATIONAL STANDARD ISO/DIS 286-1

ISO/TC **213** Secretariat: **DS**

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Geometrical product specifications (GPS) — ISO coding system for tolerances of linear sizes —

Part 1:
Bases of tolerances and fits

[Revision of first edition (ISO 286-1:1988)]

Spécification géométrique des produits (GPS) — Système de codification ISO pour les tolérances sur les tailles linéaires —

Partie 1: Base des tolérances et ajustements

ICS 17.040.10

ISO/CEN PARALLEL ENQUIRY

The CEN Secretary-General has advised the ISO Secretary-General that this ISO/DIS covers a subject of interest to European standardization. **In accordance with the ISO-lead mode of collaboration as defined in the Vienna Agreement, consultation on this ISO/DIS has the same effect for CEN members as would a CEN enquiry on a draft European Standard.** Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month FDIS vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 286-1 was prepared by Technical Committee ISO/TC 213, *Geometrical product specification and verification (GPS)*.

This second edition cancels and replaces the first edition (ISO 286-1:1988) and ISO 1829:1975 which have been technically revised.

ISO 286 consists of the following parts, under the general title *Geometrical Product Specifications (GPS) — ISO code system of tolerances for linear sizes*:

— *Part 1: Basis of tolerances and fits*

— *Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

Introduction

This International Standard is a Geometrical Product Specification (GPS) standard and is to be regarded as a general GPS standard (see ISO/TR 14638). It influences chain links 1 and 2 of the chain of standards on size in the general GPS matrix.

For more detailed information on the relation of this part of ISO 286 to other standards and the GPS matrix model see Annex C.

The need for limits and fits for machined workpieces was brought about mainly by the requirement for interchangeability between mass producted parts and the inherent inaccuracy of manufacturing methods, coupled with the fact that "exactness" of size was found to be unnecessary for the most workpiece features. In order that fit function could be satisfied, it was found sufficient to manufacture a given workpiece so that its size lay within two permissible limits, i.e. a tolerance, this being the variation in size acceptable in manufacture while ensuring the functional fit requirements of the product.

Similarly, where a specific fit condition is required between mating features of two different workpieces, it is necessary to ascribe an allowance, either positive or negative, to the nominal size to achieve the required clearance or interference. This International Standard gives the internationally accepted system of limits and fits. It provides a code system of tolerances and deviations suitable for features of size type cylinder and type two parallel planes. The intention of this code system is the fullfilment of the function fit.

The term „hole“ or „shaft“ is used to designate features of size type cylinder (e.g. for the coding of diameter of a hole or shaft) and type two parallel planes (e.g. for the coding of thickness of a key or width of a slot).

The pre-condition for the application of the ISO code system for tolerances of linear sizes for the features forming a fit is that the nominal sizes of the hole and the shaft are identical.

It has to be noted that the former edition of ISO 286-1 (1988) had the envelope criterion as the default association criterion for the size of a feature of size, but ISO 14405 changes this default association criterion to the two-point size criterion. This means that form is no longer controlled by indication of size. Therefore, ISO 286-1 shall always be used with the envelope requirement added to the ISO basic GPS specification in order to ensure the function fit.

FAST Comments

In processing this ISO/DIS 286-1 prior to its release for ballot, ISO/TC 213/AG 2 (FAST) discovered a couple of issues for which clarification is needed. Consequently, ISO/TC 213/AG 2 would like to direct the attention of the national reviewers to the following:

1) Clause 4.1.1: Grades IT0 and IT01 should be made part of the normative text as they are prerequisites for ISO 1938

2) Clause 4.2 + 4.3 + 4.4 needs a rewrite to more clearly reflect the reading/writing rules and the link to the tables and figures 7 and 8. Figure 8 should be deleted.

3) Clause 4.4.1: Grades IT0 and IT01 should be made part of the normative text as they are prerequisites for ISO 1938

Geometrical product specifications (GPS) — ISO coding system for tolerances of linear sizes —

Part 1:
Bases of tolerances and fits

1 Scope

This part of ISO 286 establishes the ISO code-system for tolerances to be used for linear sizes of for features of size of type cylinder and type two parallel planes. It translates between ISO + and – tolerancing of ISO 14405 and the ISO code system and is only applicable when the envelope requirement according to ISO 14405 is in force.

It also defines the basic concepts and the related terminology for this code system. Furthermore, it provides a standardised selection of tolerance classes for general purposes from amongst the numerous possibilities.

Finally, it defines the basic terminology for fits and explains the principles of "basic hole" and "basic shaft".

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 286-2:1988, *ISO system of limits and fits — Part 2 : Tables of standard tolerance grades and limit deviations for holes and shafts.*

ISO 3534-2:1993, *Statistics - Vocabulary and symbols — Part 2 : Statistical quality control.*

ISO 14253-1:1998, *Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1 : Decision rules for proving conformance or non-conformance with specifications.*

ISO 14405:—[1)], *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Linear size.*

ISO 14660-1:1999, *Geometrical Product Specification (GPS) — Geometrical features — Part 1 : General terms and definitions.*

International vocabulary of basic and general terms in metrology (VIM). BIPM, IEC, IFCC, ISO, UIPAC, UIPAP, OIML, 2nd edition, 1993.

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions of ISO 3534-2, ISO 14253-1, ISO 14405 and ISO14660-1 apply. It should be noted, however, that some of the terms are defined in a more restricted sense than in common usage.

1) under preparation

3.1 Basic terminology

3.1.1
feature of size
geometrical shape defined by a linear or angular dimension which is a size

[ISO 14660-1, 2.2]

NOTE 1 The features of size can be a cylinder, a sphere, two parallel opposite surfaces.

NOTE 2 In former editions, of International standards, such as ISO 286-1 and ISO 1938, the meanings of the terms "plain workpiece" and "single features" are close to that of "feature of size".

3.1.2
nominal integral feature
theoretically exact integral feature as defined by a technical drawing or by other means

[ISO 14660-1, 2.3]

3.1.3
hole
internal feature of a workpiece, including features which are not cylindrical

NOTE See also Introduction.

3.1.4
basic hole
hole chosen as a basis for a hole-basis fit system

NOTE 1 See also 3.3.4.1.

NOTE 2 For the purpose of this ISO code system, a basic hole is a hole for which the lower limit deviation is zero.

3.1.5
shaft
external feature of a workpiece, including features which are not cylindrical

NOTE See also Introduction.

3.1.6
basic shaft
shaft chosen as a basis for a shaft-basis fit system

NOTE 1 See also 3.3.4.2.

NOTE 2 For the purposes of the ISO code, a basic shaft is a shaft for which the upper deviation is zero

3.2 Terminology related to the ISO code system for tolerances of linear sizes

3.2.1
size
value either of a local size or of a global linear size or of a calculation size or of a statistical size

[ISO 14405, 3.2]

NOTE The size can only be defined on features of size.

3.2.2
nominal size
size of a feature of perfect form as defined by the designer

See Figure 1.

NOTE 1 Nominal size is used for the location of the limits of size by the application of the upper and lower deviations.

NOTE 2 In former times referred to as basic size.

3.2.3
actual size
size of the associated integral feature of size

3.2.4
limits of size
extreme permissible sizes of a feature of size

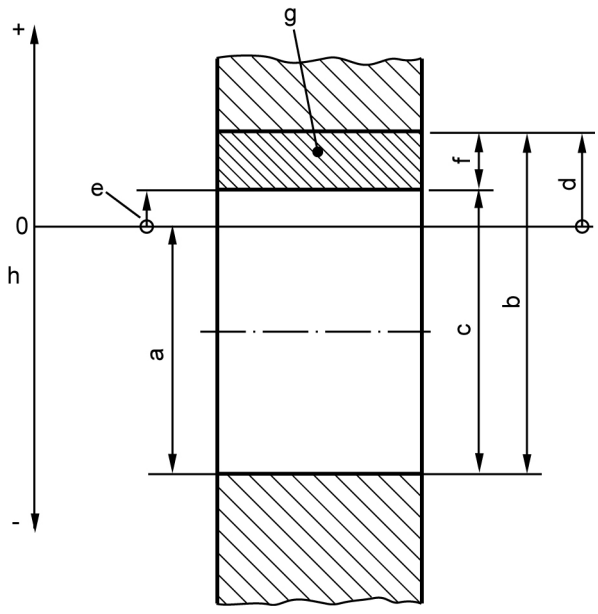
NOTE The actual size lies between the two limits of size, the limits of size are also included.

3.2.4.1
upper limit of size
ULS
largest permissible size of a feature of size

See Figure 1.

3.2.4.2
lower limit of size
LLS
smallest permissible size of a feature of size

See Figure 1.



Key
a nominal size
b upper limit of size
c lower limit of size
d upper limit deviation
e lower limit deviation (in this case also fundamental deviation)
f tolerance
g tolerance interval
h sign convention for deviations

Figure 1 — Nominal size, upper and lower limits of size and deviations, tolerances and tolerance interval

3.2.5
deviation
value minus its reference value

[VIM, clause 3.11]

NOTE For size deviations the reference value is the nominal size.

3.2.6
limit deviation (from nominal size)
upper limit deviation or lower limit deviation

3.2.6.1
upper limit deviation (from nominal size)
ES
es
upper limit of size minus nominal size

See Figure 1.

NOTE Upper limit deviation is a signed value and may be negative, zero or positive.

3.2.6.2
lower limit deviation (from nominal size)
EI
ei
lower limit of size minus nominal size

See Figure 1.

NOTE Lower limit deviation is a signed value and may be negative, zero or positive.

3.2.7
fundamental deviation
limit deviation that defines the position of the tolerance interval in relation to the nominal size

NOTE The fundamental deviation is that limit deviation, which defines that limit of size, which is the nearest to the nominal size (see Figure 1).

3.2.8
tolerance
difference between the upper and lower tolerance limits

NOTE 1 The tolerance is an absolute quantity without sign.

NOTE 2 A tolerance may be two-sided or one-sided (maximum permissible value on one side; the other limit value is zero) but the tolerance zone does not necessarily include the nominal value.

[ISO 14253-1:1998, 3.1]

NOTE 3 For the calculation the tolerance limits can be replaced by the upper limit of size and the lower limit of size, i.e. by the upper limit deviation and the lower limit deviation.

3.2.8.1
tolerance limits
specified values of the characteristic giving upper and/or lower bounds of the permissible value

[ISO 3534-2:1993, 1.4.3]

3.2.8.2
standard tolerance
IT
any tolerance belonging to the ISO code system for tolerances of linear sizes

NOTE The letters of the symbol IT stand for "International Tolerance" grade.

3.2.8.3
standard tolerance grade
group of tolerances for linear sizes characterised by a common identifier

NOTE 1 In the ISO code system for tolerances of linear sizes, the standard tolerance grade identifier consists of the IT plus the grade number (e.g. IT7), see 4.1.1.

NOTE 2 A specific tolerance grade is considered as corresponding to the same level of accuracy for all nominal sizes

3.2.8.4
tolerance interval
variable values of the characteristic between and including the tolerance limits

NOTE For the purpose of ISO 286, the former term tolerance zone used in connection with linear dimensioning (according to ISO 286-1:1988) has been changed to tolerance interval since an interval refers to a range on a scale whereas tolerance zone refers in GPS to a space or an area, e.g. tolerancing according to ISO 1101.

3.2.8.5
tolerance class
combination of a fundamental deviation and a standard tolerance grade

NOTE In the ISO code system for tolerances of linear sizes, the tolerance class identifier consists of the fundamental deviation identifier plus the grade number (e.g. D13, h9, etc), see 4.2.1.

3.3 Terminology related to the ISO fit system

The concepts in this clause relate only to nominal features of size (perfect form). For the determination of a fit see 5.2.1.

3.3.1
clearance
difference between the sizes of the hole and the shaft when the diameter of the shaft is smaller than the diameter of the hole

See Figure 2.

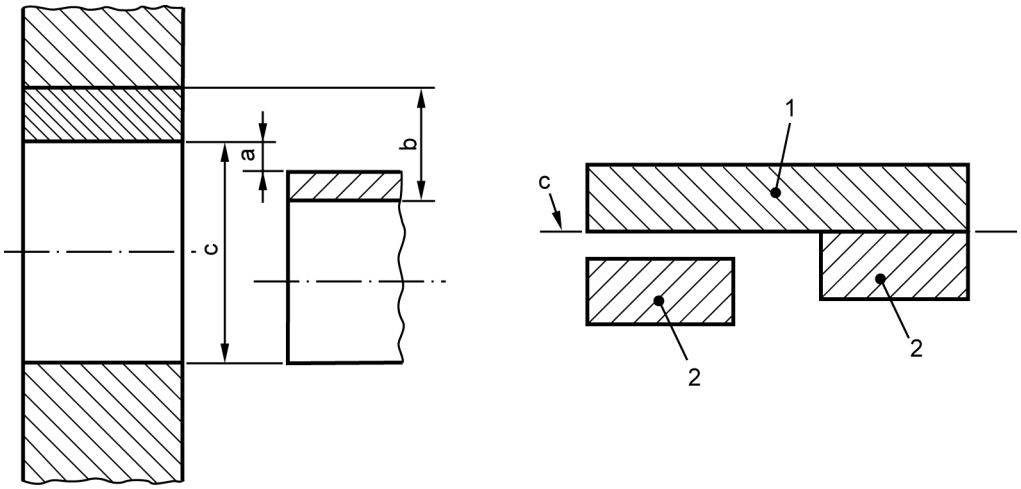
NOTE In the calculation of clearance the obtained values are positive (see Annex B).

3.3.1.1
minimum clearance
in a clearance fit, the difference between the lower limit of size of the hole and the upper limit of size of the shaft

See Figure 2.

3.3.1.2
maximum clearance
in a clearance or transition fit, the difference between the upper limit of size of the hole and the lower limit of size of the shaft

See Figures 2 and 4.



Key

a minimum clearance
b maximum clearance
c nominal size
1 tolerance interval of the hole
2 tolerance interval of the shaft

Figure 2 — Schematic representation of a clearance fit

3.3.2
interference
difference between the sizes of the hole and the shaft when the diameter of the shaft is larger than the diameter of the hole

See Figure 3.

NOTE In the calculation of an interference the obtained values are negative (see Annex B).

3.3.2.1
minimum interference
in an interference fit, the difference between the upper limit of size of the hole and the lower limit of size of the shaft

See Figure 3.

3.3.2.2
maximum interference
in an interference or transition fit, the difference between the lower limit of size of the hole and the upper limit of size of the shaft

See Figures 3 and 4.

3.3.3
fit
assembly of an external and an internal feature of size of the same type

NOTE The pre-condition for the application of the ISO code system for tolerances of linear sizes for the features forming a fit is that the nominal sizes of the hole and the shaft are identical.