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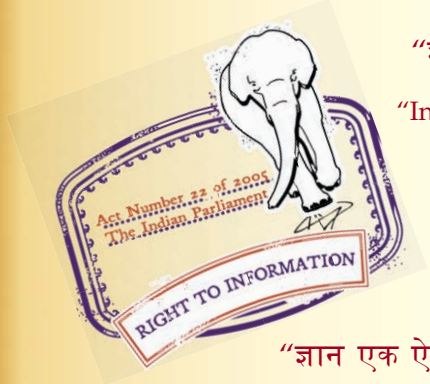
IS 919-1 (1993): ISO Systems of limits and fits, Part 1: Bases of tolerance, deviations and fits [PGD 20: Engineering Standards]



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Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS 919 (Part 1) : 1993
ISO 286-1 : 1988
(Reaffirmed 1998)

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भाग 1 छूटों, त्रिचलनों और उपयुक्तताओं के आधार

(दूसरा पुनरीक्षण)

Indian Standard

ISO SYSTEM OF LIMITS AND FITS

PART 1 BASES OF TOLERANCES, DEVIATIONS AND FITS

(Second Revision)

Third Reprint JUNE 1997

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CONTENTS

NATIONAL FOREWORD

This Indian Standard (Second Revision) which is identical with ISO 286-1 : 1988 'ISO system of limits and fits — Part 1 : Bases of tolerances, deviations and fits' was adopted by the Bureau of Indian Standards on the recommendations of the Engineering Standards Sectional Committee (LM 01) and approval of the Light Mechanical Engineering Division Council.

The standard was originally published in 1959. It was subsequently revised in 1963 taking assistance from ISO/R 286-1962 'ISO system of limits and fits, general tolerances and deviations'.

This revision has been made to harmonize the standard with ISO 286-1 : 1988. in the present revision following have been incorporated:

a) Two additional grades, that is, IT 17 and IT 18.
b) Method of transmitting the information on equipment with limit character such as telex.
c) Certain additional tolerance classes.
d) Information for sizes up to 3 150 mm.
e) Deviations requirement of most common shafts and holes such as cd, CD, ef, EF, fg, FG for sizes up to 10 mm which were earlier being covered in IS 919 (Part 2) : 1979 'Recommendations for limits and fits for engineering : Part 2 Fine mechanism and horology'.

IS 2709 : 1982 'Guide for the selection of fits (*first revision*)' and IS 8841 : 1978 'Recommendations for limits and fits for sizes above 3 150 mm up to 10 000 mm' are the related published Indian Standards to this subject.

(*Continued on third cover*)

Indian Standard

ISO SYSTEM OF LIMITS AND FITS

PART 1 BASES OF TOLERANCES, DEVIATIONS AND FITS

(Second Revision)

0 Introduction

The need for limits and fits for machined workpieces was brought about mainly by the inherent inaccuracy of manufacturing methods, coupled with the fact that "exactness" of size was found to be unnecessary for most workpieces. In order that 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.

Similarly, where a specific fit condition is required between mating workpieces, it is necessary to ascribe an allowance, either positive or negative, to the basic size to achieve the required clearance or interference, i.e. a "deviation".

With developments in industry and international trade, it became necessary to develop formal systems of limits and fits, firstly at the industrial level, then at the national level and later at the international level.

This International Standard therefore gives the internationally accepted system of limits and fits.

Annexes A and B give the basic formulae and rules necessary for establishing the system, and examples in the use of the standard are to be regarded as an integral part of the standard.

Annex C gives a list of equivalent terms used in ISO 286 and other International Standards on tolerances.

1 Scope

This part of ISO 286 gives the bases of the ISO system of limits and fits together with the calculated values of the standard tolerances and fundamental deviations. These values shall be taken as authoritative for the application of the system (see also clause A.1).

This part of ISO 286 also gives terms and definitions together with associated symbols.

2 Field of application

The ISO system of limits and fits provides a system of tolerances and deviations suitable for plain workpieces.

For simplicity and also because of the importance of cylindrical workpieces of circular section, only these are referred to explicitly. It should be clearly understood, however, that the tolerances and deviations given in this International Standard equally apply to workpieces of other than circular section.

In particular, the general term "hole" or "shaft" can be taken as referring to the space contained by (or containing) the two parallel faces (or tangent planes) of any workpiece, such as the width of a slot or the thickness of a key.

The system also provides for fits between mating cylindrical features or fits between workpieces having features with parallel faces, such as the fit between a key and keyway, etc.

NOTE — It should be noted that the system is not intended to provide fits for workpieces with features having other than simple geometric forms.

For the purposes of this part of ISO 286, a simple geometric form consists of a cylindrical surface area or two parallel planes.

3 References

NOTE — See also clause 10.

ISO 1, *Standard reference temperature for industrial length measurements.*

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

ISO/R 1938, *ISO system of limits and fits — Inspection of plain workpieces.* [1)]

ISO 8015, *Technical drawings — Fundamental tolerancing principle.*

1) At present under revision.

4 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply. It should be noted, however, that some of the terms are defined in a more restricted sense than in common usage.

4.1 shaft: A term used, according to convention, to describe an external feature of a workpiece, including features which are not cylindrical (see also clause 2).

4.1.1 basic shaft: Shaft chosen as a basis for a shaft-basis system of fits (see also 4.11.1).

For the purposes of the ISO system of limits and fits, a shaft the upper deviation of which is zero.

4.2 hole: A term used, according to convention, to describe an internal feature of a workpiece, including features which are not cylindrical (see also clause 2).

4.2.1 basic hole: Hole chosen as a basis for a hole-basis system of fits (see also 4.11.2).

For the purposes of the ISO system of limits and fits, a hole the lower deviation of which is zero.

4.3 size: A number expressing, in a particular unit, the numerical value of a linear dimension.

4.3.1 basic size; nominal size: The size from which the limits of size are derived by the application of the upper and lower deviations (see figure 1).

NOTE — The basic size can be a whole number or a decimal number, e.g. 32; 15; 8,75; 0,5; etc.

4.3.2 actual size: The size of a feature, obtained by measurement.

4.3.2.1 actual local size: Any individual distance at any cross-section of a feature, i.e. any size measured between any two opposite points.

4.3.3 limits of size: The two extreme permissible sizes of a feature, between which the actual size should lie, the limits of size being included.

4.3.3.1 maximum limit of size: The greatest permissible size of a feature (see figure 1).

4.3.3.2 minimum limit of size: The smallest permissible size of a feature (see figure 1).

4.4 limit system: A system of standardized tolerances and deviations.

4.5 zero line: In a graphical representation of limits and fits, the straight line, representing the basic size, to which the deviations and tolerances are referred (see figure 1).

According to convention, the zero line is drawn horizontally, with positive deviations shown above and negative deviations below (see figure 2).

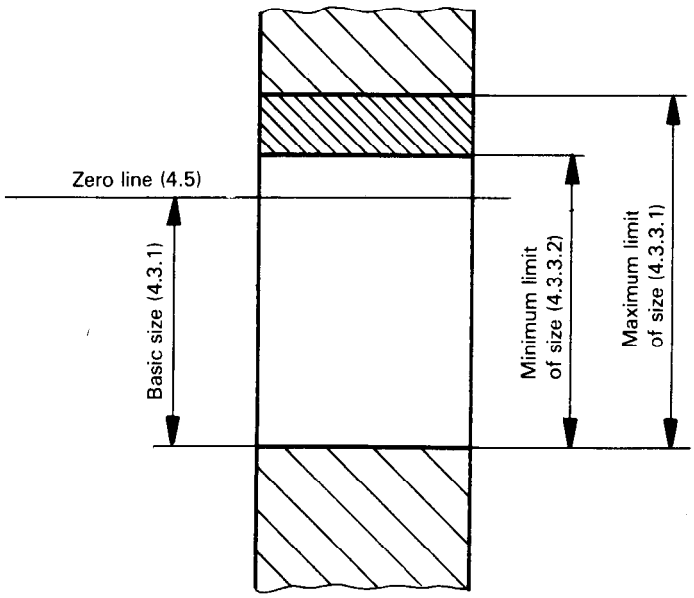


Figure 1 — Basic size, and maximum and minimum limits of size

4.6 deviation: The algebraic difference between a size (actual size, limit of size, etc.) and the corresponding basic size.

NOTE — Symbols for shaft deviations are lower case letters (*es*, *ei*) and symbols for hole deviations are upper case letters (*ES*, *EI*) (see figure 2).

4.6.1 limit deviations: Upper deviation and lower deviation.

4.6.1.1 upper deviation (*ES*, *es*): The algebraic difference between the maximum limit of size and the corresponding basic size (see figure 2).

4.6.1.2 lower deviation (*EI*, *ei*): The algebraic difference between the minimum limit of size and the corresponding basic size (see figure 2).

4.6.2 fundamental deviation: For the purposes of the ISO system of limits and fits, that deviation which defines the position of the tolerance zone in relation to the zero line (see figure 2).

NOTE — This may be either the upper or lower deviation, but, according to convention, the fundamental deviation is the one nearest the zero line.

4.7 size tolerance: The difference between the maximum limit of size and the minimum limit of size, i.e. the difference between the upper deviation and the lower deviation.

NOTE — The tolerance is an absolute value without sign.

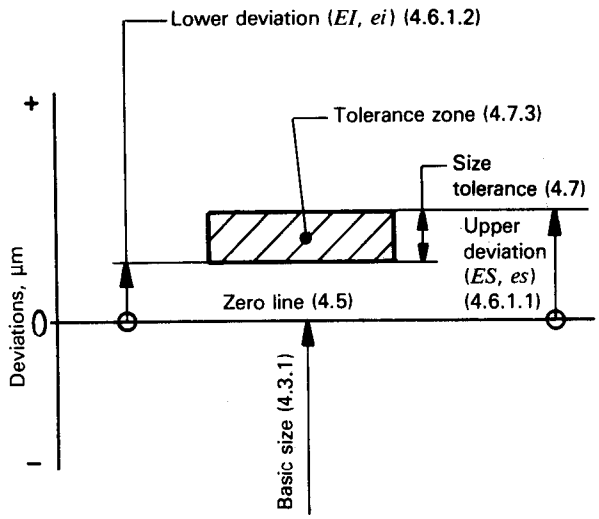


Figure 2 — Conventional representation of a tolerance zone

4.7.1 standard tolerance (IT): For the purposes of the ISO system of limits and fits, any tolerance belonging to this system.

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

4.7.2 standard tolerance grades: For the purposes of the ISO system of limits and fits, a group of tolerances (e.g. IT7), considered as corresponding to the same level of accuracy for all basic sizes.

4.7.3 tolerance zone: In a graphical representation of tolerances, the zone, contained between two lines representing the maximum and minimum limits of size, defined by the magnitude of the tolerance and its position relative to the zero line (see figure 2).

4.7.4 tolerance class: The term used for a combination of fundamental deviation and a tolerance grade, e.g. h9, D13, etc.

4.7.5 standard tolerance factor (*i*, *I*): For the purposes of the ISO system of limits and fits, a factor which is a function of the basic size, and which is used as a basis for the determination of the standard tolerances of the system.

NOTES

1 The standard tolerance factor *i* is applied to basic sizes less than or equal to 500 mm.

2 The standard tolerance factor *I* is applied to basic sizes greater than 500 mm.

4.8 clearance: The positive difference between the sizes of the hole and the shaft, before assembly, when the diameter of the shaft is smaller than the diameter of the hole (see figure 3).

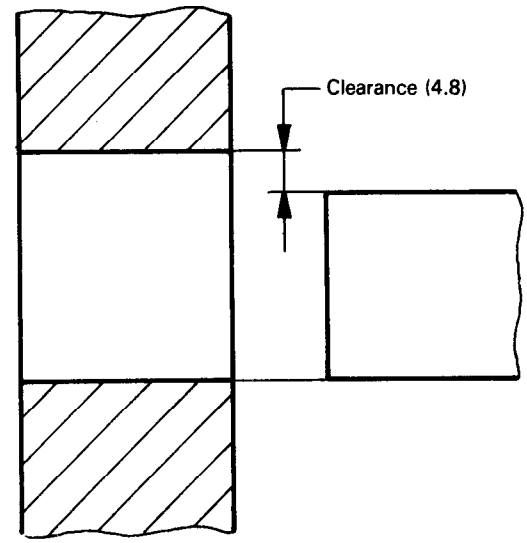


Figure 3 — Clearance

4.8.1 minimum clearance: In a clearance fit, the positive difference between the minimum limit of size of the hole and the maximum limit of size of the shaft (see figure 4).

4.8.2 maximum clearance: In a clearance or transition fit, the positive difference between the maximum limit of size of the hole and the minimum limit of size of the shaft (see figures 4 and 5).

4.9 interference: The negative difference between the sizes of the hole and the shaft, before assembly, when the diameter of the shaft is larger than the diameter of the hole (see figure 6).

4.9.1 minimum interference: In an interference fit, the negative difference, before assembly, between the maximum limit of size of the hole and the minimum limit of size of the shaft (see figure 7).

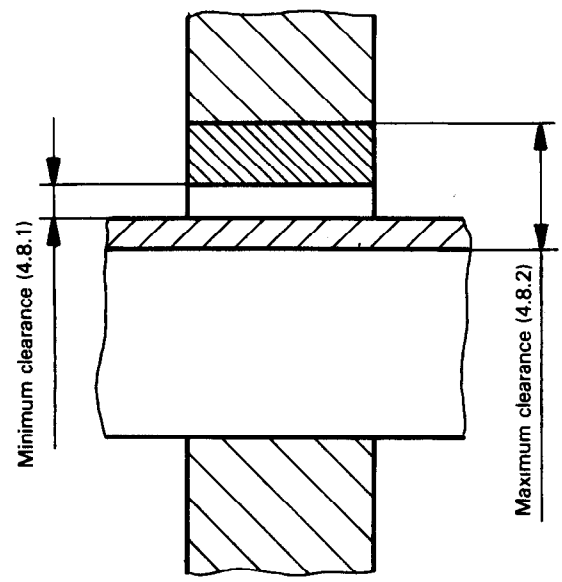


Figure 4 — Clearance fit

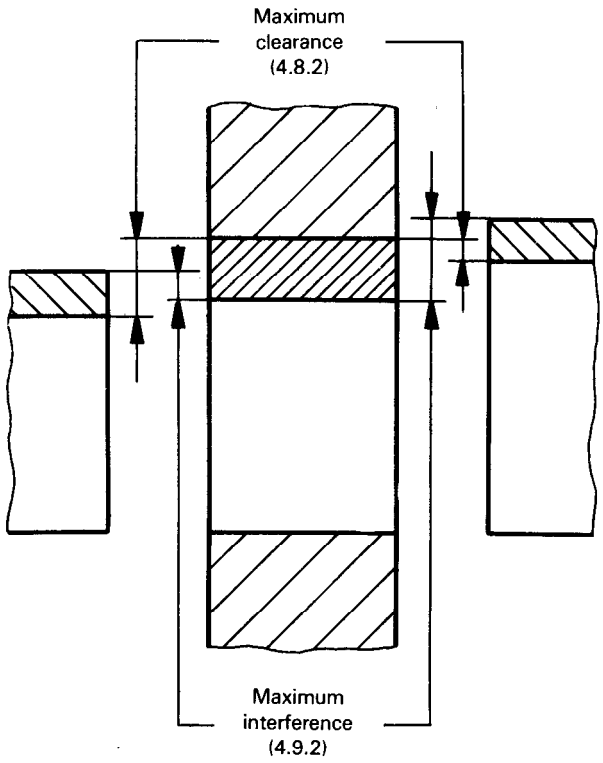


Figure 5 — Transition fit

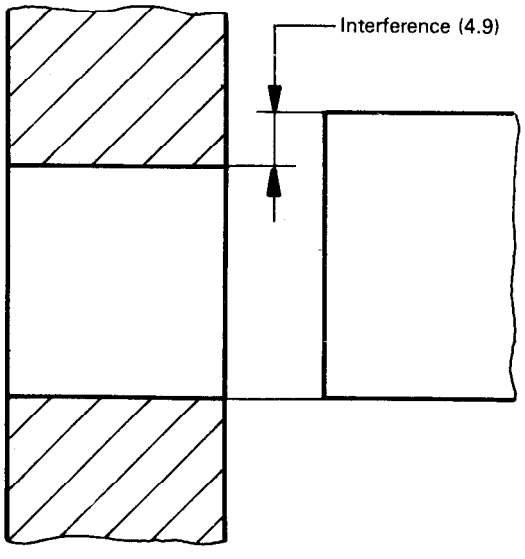


Figure 6 — Interference

4.9.2 maximum interference: In an interference or transition fit, the negative difference, before assembly, between the minimum limit of size of the hole and the maximum limit of size of the shaft (see figures 5 and 7).

4.10 fit: The relationship resulting from the difference, before assembly, between the sizes of the two features (the hole and the shaft) which are to be assembled.

NOTE — The two mating parts of a fit have a common basic size.

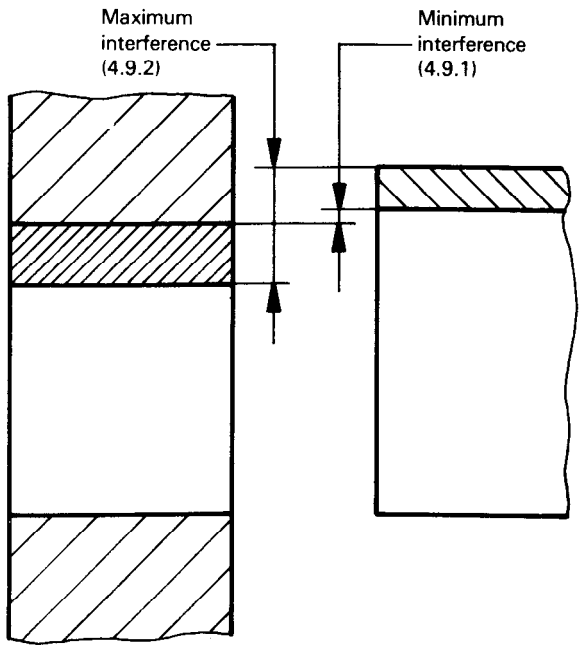


Figure 7 — Interference fit

4.10.1 clearance fit: A fit that always provides a clearance between the hole and shaft when assembled, i.e. the minimum size of the hole is either greater than or, in the extreme case, equal to the maximum size of the shaft (see figure 8).

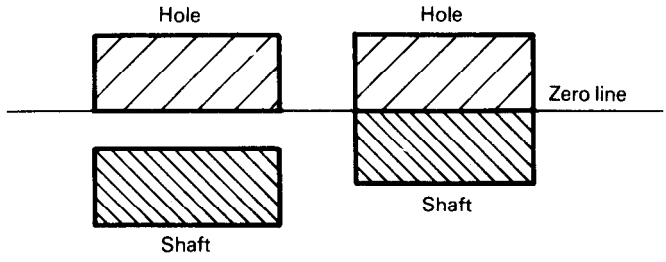


Figure 8 — Schematic representation of clearance fits

4.10.2 interference fit: A fit which everywhere provides an interference between the hole and shaft when assembled, i.e. the maximum size of the hole is either smaller than or, in the extreme case, equal to the minimum size of the shaft (see figure 9).

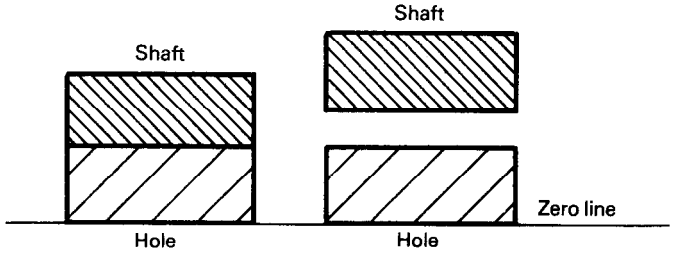


Figure 9 — Schematic representation of interference fits

4.10.3 transition fit: A fit which may provide either a clearance or an interference between the hole and shaft when assembled, depending on the actual sizes of the hole and shaft, i.e. the tolerance zones of the hole and the shaft overlap completely or in part (see figure 10).

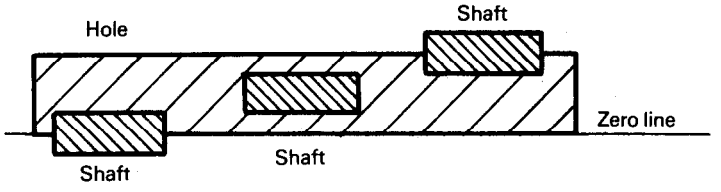


Figure 10 — Schematic representation of transition fits

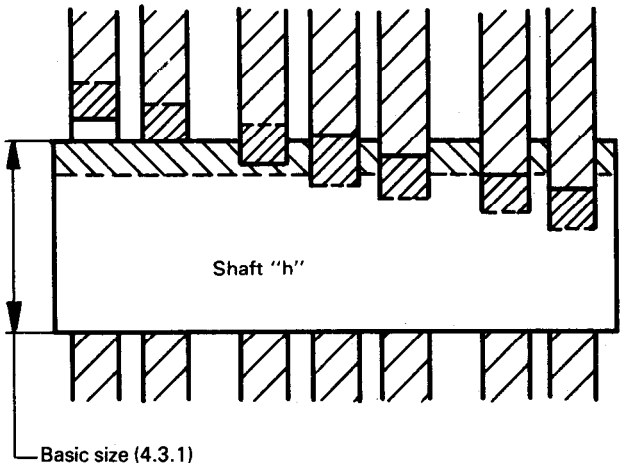
4.10.4 variation of a fit: The arithmetic sum of the tolerances of the two features comprising the fit.

NOTE — The variation of a fit is an absolute value without sign.

4.11 fit system: A system of fits comprising shafts and holes belonging to a limit system.

4.11.1 shaft-basis system of fits: A system of fits in which the required clearances or interferences are obtained by associating holes of various tolerance classes with shafts of a single tolerance class.

For the purposes of the ISO system of limits and fits, a system of fits in which the maximum limit of size of the shaft is identical to the basic size, i.e. the upper deviation is zero (see figure 11).



NOTES

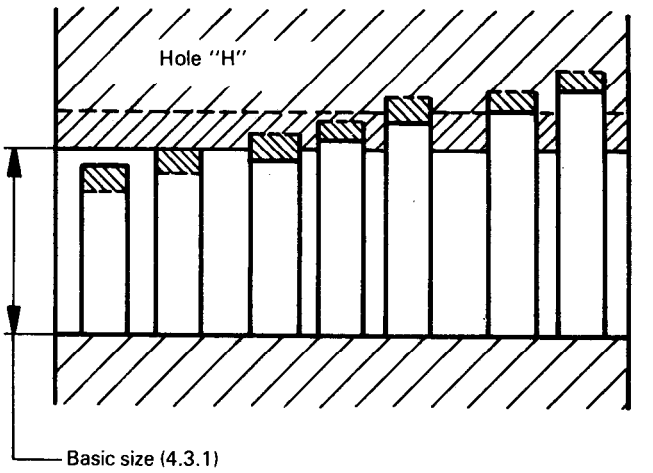
1 The horizontal continuous lines represent the fundamental deviations for holes or shafts.

2 The dashed lines represent the other limits and show the possibility of different combinations between holes and shafts, related to their grade of tolerance (e.g. G7/h4, H6/h4, M5/h4).

Figure 11 — Shaft-basis system of fits

4.11.2 hole-basis system of fits: A system of fits in which the required clearances or interferences are obtained by associating shafts of various tolerance classes with holes of a single tolerance class.

For the purposes of the ISO system of limits and fits, a system of fits in which the minimum limit of size of the hole is identical to the basic size, i.e. the lower deviation is zero (see figure 12).



NOTES

1 The horizontal continuous lines represent the fundamental deviations for holes or shafts.

2 The dashed lines represent the other limits and show the possibility of different combinations between holes and shafts, related to their grade of tolerance (e.g. H6/h6, H6/js5, H6/p4).

Figure 12 — Hole-basis system of fits

4.12 maximum material limit (MML): The designation applied to that of the two limits of size which corresponds to the maximum material size for the feature, i.e.

— the maximum (upper) limit of size for an external feature (shaft),

— the minimum (lower) limit of size for an internal feature (hole).

NOTE — Previously called "GO limit".

4.13 least material limit (LML): The designation applied to that of the two limits of size which corresponds to the minimum material size for the feature, i.e.

— the minimum (lower) limit of size for an external feature (shaft),

— the maximum (upper) limit of size for an internal feature (hole).

NOTE — Previously called "NOT GO limit".

5 Symbols, designation and interpretation of tolerances, deviations and fits

5.1 Symbols

5.1.1 Standard tolerance grades

The standard tolerance grades are designated by the letters IT followed by a number, e.g. IT7. When the tolerance grade is associated with (a) letter(s) representing a fundamental deviation to form a tolerance class, the letters IT are omitted, e.g. h7.

NOTE — The ISO system provides for a total of 20 standard tolerance grades of which grades IT1 to IT18 are in general use and are given in the main body of the standard. Grades IT0 and IT01, which are not in general use, are given in annex A for information purposes.

5.1.2 Deviations

5.1.2.1 Position of tolerance zone

The position of the tolerance zone with respect to the zero line, which is a function of the basic size, is designated by (an) upper case letter(s) for holes (A . . . ZC) or (a) lower case letter(s) for shafts (a . . . zc) (see figures 13 and 14).

NOTE — To avoid confusion, the following letters are not used:

I, i; L, l; O, o; Q, q; W, w.

5.1.2.2 Upper deviations

The upper deviations are designated by the letters "*ES*" for holes and the letters "*es*" for shafts.

5.1.2.3 Lower deviations

The lower deviations are designated by the letters "*EI*" for holes and the letters "*ei*" for shafts.

5.2 Designation

5.2.1 Tolerance class

A tolerance class shall be designated by the letter(s) representing the fundamental deviation followed by the number representing the standard tolerance grade.

Examples:

H7 (holes)
h7 (shafts)

5.2.2 Toleranced size

A toleranced size shall be designated by the basic size followed by the designation of the required tolerance class, or the explicit deviations.

Examples:

32H7
80js15
100g6
$100\ ^{-0,012}_{-0,034}$

ATTENTION — In order to distinguish between holes and shafts when transmitting information on equipment with limited character sets, such as telex, the designation shall be prefixed by the following letters:

— H or h for holes;

— S or s for shafts.

Examples:

50H5 becomes H50H5 or h50h5
50h6 becomes S50H6 or s50h6

This method of designation shall not be used on drawings.

5.2.3 Fit

A fit requirement between mating features shall be designated by

a) the common basic size;

b) the tolerance class symbol for the hole;

c) the tolerance class symbol for the shaft.

Examples:

52H7/g6 or $52\ \frac{H7}{g6}$

ATTENTION — In order to distinguish between the hole and the shaft when transmitting information on equipment with limited character sets, such as telex, the designation shall be prefixed by the following letters:

— H or h for holes;

— S or s for shafts;

— and the basic size repeated.

Examples:

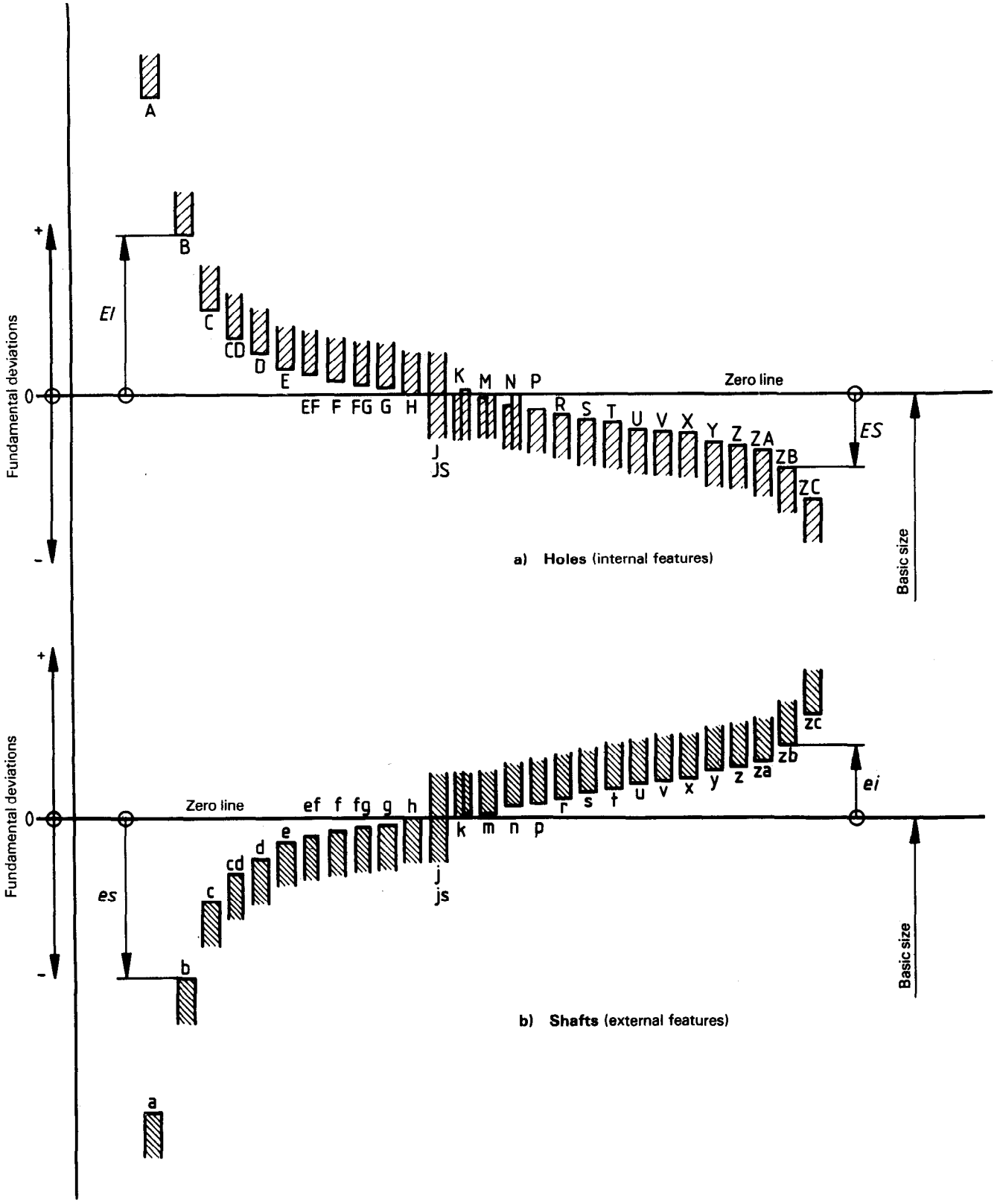
52H7/g6 becomes H52H7/S52G6 or h52h7/s52g6

This method of designation shall not be used on drawings.

5.3 Interpretation of a toleranced size

5.3.1 Tolerance indication in accordance with ISO 8015

The tolerances for workpieces manufactured to drawings marked with the notation, **Tolerancing ISO 8015**, shall be interpreted as indicated in 5.3.1.1 and 5.3.1.2.

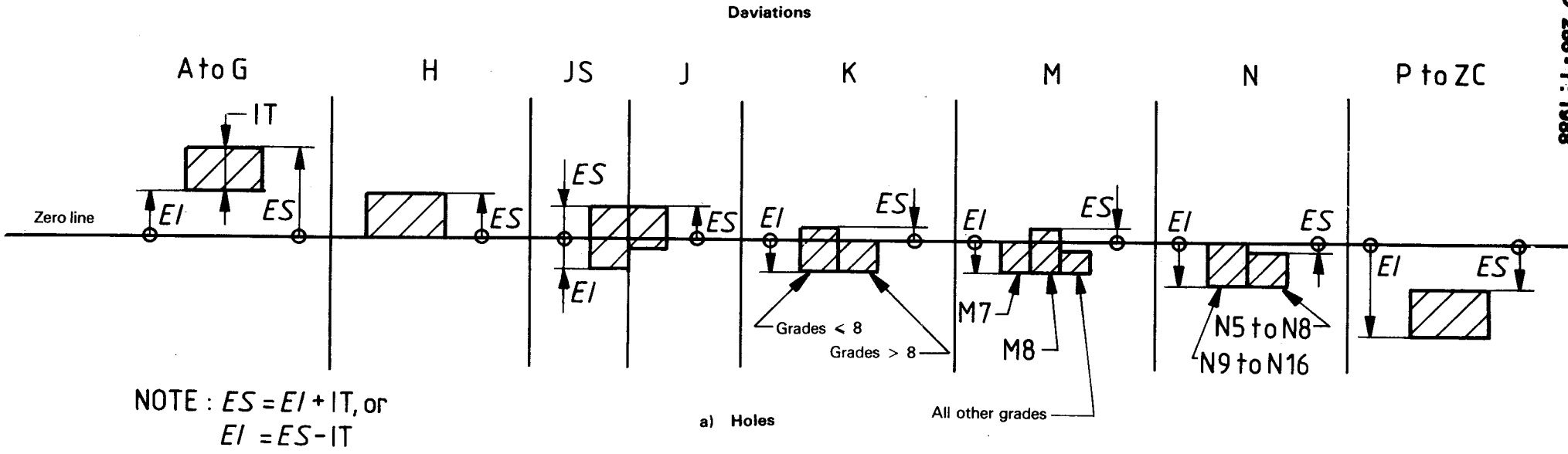


NOTES

1 According to convention, the fundamental deviation is the one defining the nearest limit to the zero line.

2 For details concerning fundamental deviations for J/j, K/k, M/m and N/n, see figure 14.

Figure 13 — Schematic representation of the positions of fundamental deviations



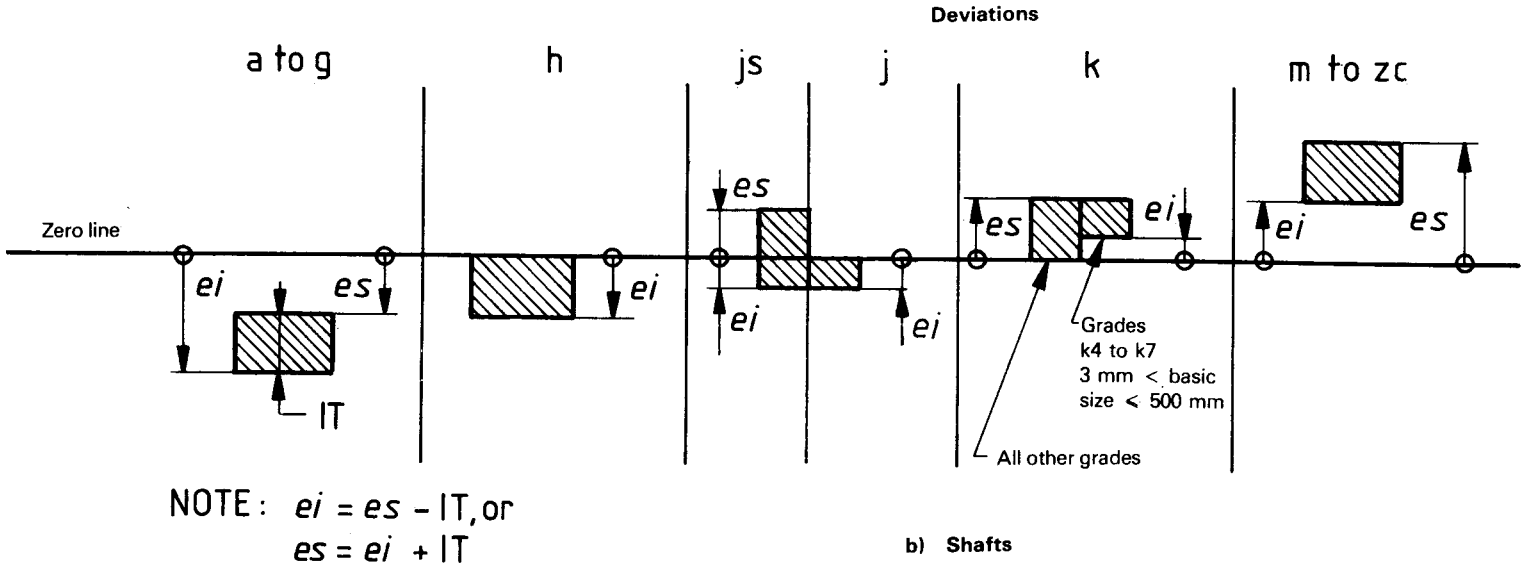


Figure 14 — Deviations for shafts and holes

5.3.1.1 Linear size tolerances

A linear size tolerance controls only the actual local sizes (two-point measurements) of a feature, but not its form deviations (for example circularity and straightness deviations of a cylindrical feature or flatness deviations of parallel surfaces). There is no control of the geometrical interrelationship of individual features by the size tolerances. (For further information, see ISO/R 1938 and ISO 8015.)

5.3.1.2 Envelope requirement

Single features, whether a cylinder, or established by two parallel planes, having the function of a fit between mating parts, are indicated on the drawing by the symbol Ⓔ in addition to the dimension and tolerance. This indicates a mutual dependence of size and form which requires that the envelope of perfect form for the feature at maximum material size shall not be violated. (For further information, see ISO/R 1938 and ISO 8015.)

NOTE — Some national standards (which should be referred to on the drawing) specify that the envelope requirement for single features is the norm and therefore this is not indicated separately on the drawing.

5.3.2 Tolerance indication not in accordance with ISO 8015

The tolerances for workpieces manufactured to drawings which **do not** have the notation, **Tolerancing ISO 8015**, shall be interpreted in the following ways within the stipulated length:

a) **For holes**

The diameter of the largest perfect imaginary cylinder, which can be inscribed within the hole so that it just contacts the highest points of the surface, should not be smaller than the maximum material limit of size. The maximum diameter at **any position** in the hole shall not exceed the least material limit of size.

b) **For shafts**

The diameter of the smallest perfect imaginary cylinder, which can be circumscribed about the shaft so that it just contacts the highest points of the surface, should not be larger than the maximum material limit of size. The minimum diameter at **any position** on the shaft shall be not less than the least material limit of size.

The interpretations given in a) and b) mean that if a workpiece is everywhere at its maximum material limit, that workpiece should be perfectly round and straight, i.e. a perfect cylinder.

Unless otherwise specified, and subject to the above requirements, departures from a perfect cylinder may reach the full value of the diameter tolerance specified. For further information, see ISO/R 1938.

NOTE — In special cases, the maximum form deviations permitted by the interpretations given in a) and b) may be too large to allow satisfactory functioning of the assembled parts: in such cases, separate tolerances should be given for the form, e.g. separate tolerances on circularity and/or straightness (see ISO 1101).

6 Graphical representation

The major terms and definitions given in clause 4 are illustrated in figure 15.

In practice, a schematic diagram such as that shown in figure 16 is used for simplicity. In this diagram, the axis of the workpiece, which is not shown in the figure, according to convention always lies below the diagram.

In the example illustrated, the two deviations of the hole are positive and those of the shaft are negative.

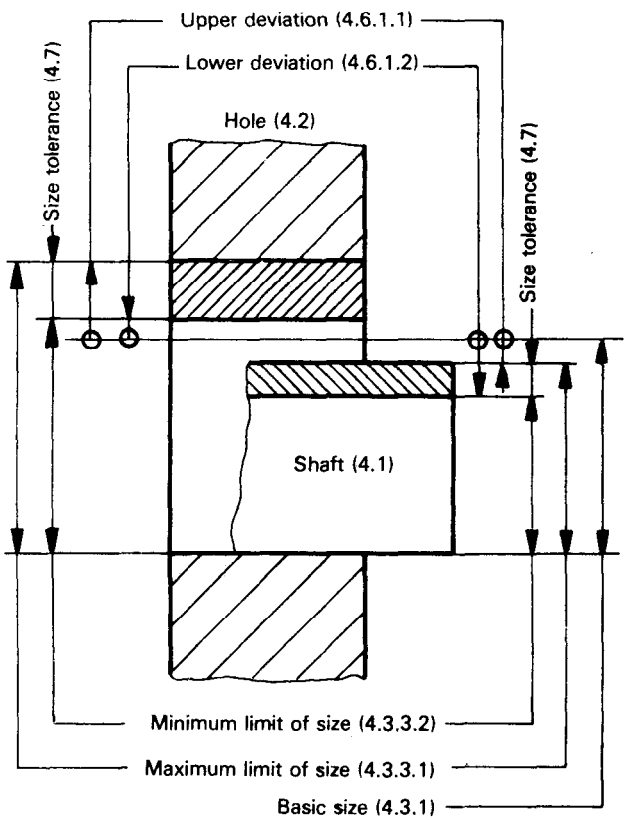


Figure 15 — Graphical representation

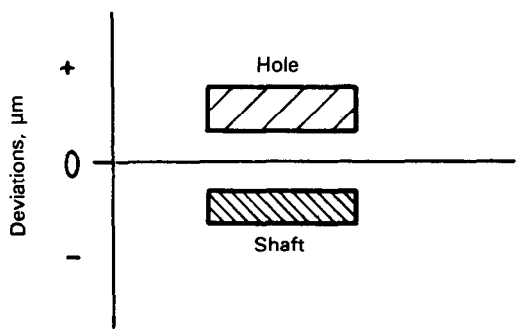


Figure 16 — Simplified schematic diagram

7 Reference temperature

The temperature at which the dimensions of the ISO system of limits and fits are specified is 20 °C (see ISO 1).

8 Standard tolerances for basic sizes up to 3 150 mm

8.1 Basis of the system

The bases for calculating the standard tolerances are given in annex A.

8.2 Values of standard tolerance grades (IT)

Values of standard tolerance grades IT1 to IT18 inclusive are given in table 1. These values are to be taken as authoritative for the application of the system.

NOTE — Values for standard tolerance grades IT0 and IT01 are given in annex A.

9 Fundamental deviations for basic sizes up to 3 150 mm

9.1 Fundamental deviations for shafts
[except deviation js (see 9.3)]

The fundamental deviations for shafts and their respective sign (+ or −) are shown in figure 17. Values for the fundamental deviations are given in table 2.

The upper deviation (*es*) and lower deviation (*ei*) are established from the fundamental deviation and the standard tolerance grade (IT) as shown in figure 17.

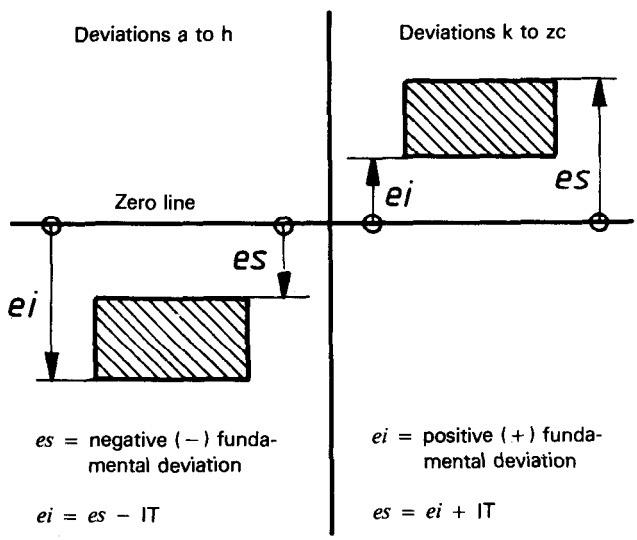


Figure 17 — Deviations for shafts

9.2 Fundamental deviations for holes
[except deviation JS (see 9.3)]

The fundamental deviations for holes and their respective sign (+ or −) are shown in figure 18. Values for the fundamental deviations are given in table 3.

The upper deviation (*ES*) and lower deviation (*EI*) are established from the fundamental deviation and the standard tolerance grade (IT) as shown in figure 18.

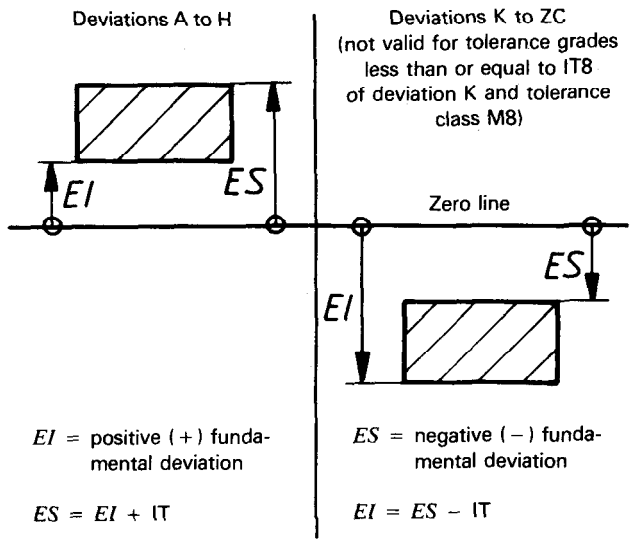


Figure 18 — Deviations for holes

9.3 Fundamental deviations js and JS
(see figure 19)

The information given in 9.1 and 9.2 does not apply to fundamental deviations js and JS, which are a symmetrical distribution of the standard tolerance grade about the zero line, i.e. for js:

$$es = ei = \frac{IT}{2}$$

and for JS:

$$ES = EI = \frac{IT}{2}$$

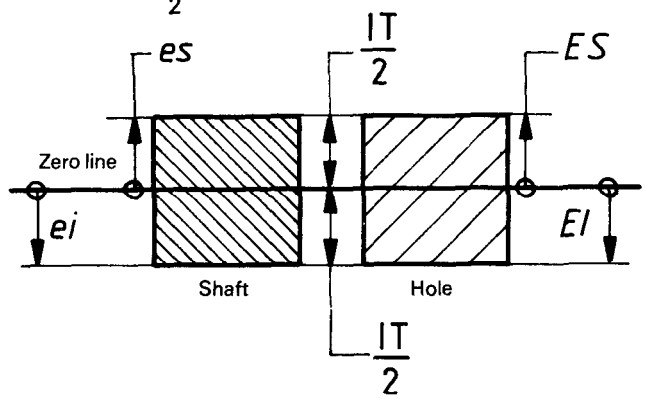


Figure 19 — Deviations js and JS

9.4 Fundamental deviations j and J

The information given in 9.1 to 9.3 does not apply to fundamental deviations j and J, which are, for the most part, asymmetrical distributions of the standard tolerance grade about the zero line (see ISO 286-2, tables 8 and 24).

Table 1 — Numerical values of standard tolerance grades IT for basic sizes up to 3 150 mm [1]

Basic size mm		Standard tolerance grades																	
		IT1[2]	IT2[2]	IT3[2]	IT4[2]	IT5[2]	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13	IT14[3]	IT15[3]	IT16[3]	IT17[3]	IT18[3]
Above	Up to and including	Tolerances																	
		μm											mm						
–	3[3]	0,8	1,2	2	3	4	6	10	14	25	40	60	0,1	0,14	0,25	0,4	0,6	1	1,4
3	6	1	1,5	2,5	4	5	8	12	18	30	48	75	0,12	0,18	0,3	0,48	0,75	1,2	1,8
6	10	1	1,5	2,5	4	6	9	15	22	36	58	90	0,15	0,22	0,36	0,58	0,9	1,5	2,2
10	18	1,2	2	3	5	8	11	18	27	43	70	110	0,18	0,27	0,43	0,7	1,1	1,8	2,7
18	30	1,5	2,5	4	6	9	13	21	33	52	84	130	0,21	0,33	0,52	0,84	1,3	2,1	3,3
30	50	1,5	2,5	4	7	11	16	25	39	62	100	160	0,25	0,39	0,62	1	1,6	2,5	3,9
50	80	2	3	5	8	13	19	30	46	74	120	190	0,3	0,46	0,74	1,2	1,9	3	4,6
80	120	2,5	4	6	10	15	22	35	54	87	140	220	0,35	0,54	0,87	1,4	2,2	3,5	5,4
120	180	3,5	5	8	12	18	25	40	63	100	160	250	0,4	0,63	1	1,6	2,5	4	6,3
180	250	4,5	7	10	14	20	29	46	72	115	185	290	0,46	0,72	1,15	1,85	2,9	4,6	7,2
250	315	6	8	12	16	23	32	52	81	130	210	320	0,52	0,81	1,3	2,1	3,2	5,2	8,1
315	400	7	9	13	18	25	36	57	89	140	230	360	0,57	0,89	1,4	2,3	3,6	5,7	8,9
400	500	8	10	15	20	27	40	63	97	155	250	400	0,63	0,97	1,55	2,5	4	6,3	9,7
500	630[2]	9	11	16	22	32	44	70	110	175	280	440	0,7	1,1	1,75	2,8	4,4	7	11
630	800[2]	10	13	18	25	36	50	80	125	200	320	500	0,8	1,25	2	3,2	5	8	12,5
800	1000[2]	11	15	21	28	40	56	90	140	230	360	560	0,9	1,4	2,3	3,6	5,6	9	14
1000	1250[2]	13	18	24	33	47	66	105	165	260	420	660	1,05	1,65	2,6	4,2	6,6	10,5	16,5
1250	1600[2]	15	21	29	39	55	78	125	195	310	500	780	1,25	1,95	3,1	5	7,8	12,5	19,5
1600	2000[2]	18	25	35	46	65	92	150	230	370	600	920	1,5	2,3	3,7	6	9,2	15	23
2000	2500[2]	22	30	41	55	78	110	175	280	440	700	1100	1,75	2,8	4,4	7	11	17,5	28
2500	3150[2]	26	36	50	68	96	135	210	330	540	860	1350	2,1	3,3	5,4	8,6	13,5	21	33

1) Values for standard tolerance grades IT01 and IT0 for basic sizes less than or equal to 500 mm are given in annex A, table 5.

2) Values for standard tolerance grades IT1 to IT5 (incl.) for basic sizes over 500 mm are included for experimental use.

3) Standard tolerance grades IT14 to IT18 (incl.) shall not be used for basic sizes less than or equal to 1 mm.

Table 2 — Numerical values of the

Basic size mm		Upper deviation *es*												Fundamental		
		All standard tolerance grades												IT5 and IT6	IT7	IT8
Above	Up to and including	a[1]	b[1]	c	cd	d	e	ef	f	fg	g	h	js[2]	j		
—	3[1]	− 270	− 140	− 60	− 34	− 20	− 14	− 10	− 6	− 4	− 2	0	Deviations = $\pm \frac{IT_n}{2}$, where n is the IT value number	− 2	− 4	− 6
3	6	− 270	− 140	− 70	− 46	− 30	− 20	− 14	− 10	− 6	− 4	0		− 2	− 4	
6	10	− 280	− 150	− 80	− 56	− 40	− 25	− 18	− 13	− 8	− 5	0		− 2	− 5	
10	14	− 290	− 150	− 95		− 50	− 32		− 16		− 6	0		− 3	− 6	
14	18															
18	24	− 300	− 160	− 110		− 65	− 40		− 20		− 7	0		− 4	− 8	
24	30															
30	40	− 310	− 170	− 120		− 80	− 50		− 25		− 9	0		− 5	− 10	
40	50	− 320	− 180	− 130												
50	65	− 340	− 190	− 140		− 100	− 60		− 30		− 10	0		− 7	− 12	
65	80	− 360	− 200	− 150												
80	100	− 380	− 220	− 170		− 120	− 72		− 36		− 12	0		− 9	− 15	
100	120	− 410	− 240	− 180												
120	140	− 460	− 260	− 200		− 145	− 85		− 43		− 14	0		− 11	− 18	
140	160	− 520	− 280	− 210												
160	180	− 580	− 310	− 230												
180	200	− 660	− 340	− 240		− 170	− 100		− 50		− 15	0		− 13	− 21	
200	225	− 740	− 380	− 260												
225	250	− 820	− 420	− 280												
250	280	− 920	− 480	− 300		− 190	− 110		− 56		− 17	0		− 16	− 26	
280	315	− 1 050	− 540	− 330												
315	355	− 1 200	− 600	− 360		− 210	− 125		− 62		− 18	0		− 18	− 28	
355	400	− 1 350	− 680	− 400												
400	450	− 1 500	− 760	− 440		− 230	− 135		− 68		− 20	0		− 20	− 32	
450	500	− 1 650	− 840	− 480												
500	560					− 260	− 145		− 76		− 22	0				
560	630															
630	710					− 290	− 160		− 80		− 24	0				
710	800															
800	900					− 320	− 170		− 86		− 26	0				
900	1 000															
1 000	1 120					− 350	− 195		− 98		− 28	0				
1 120	1 250															
1 250	1 400					− 390	− 220		− 110		− 30	0				
1 400	1 600															
1 600	1 800					− 430	− 240		− 120		− 32	0				
1 800	2 000															
2 000	2 240					− 480	− 260		− 130		− 34	0				
2 240	2 500															
2 500	2 800					− 520	− 290		− 145		− 38	0				
2 800	3 150															

1) Fundamental deviations a and b shall not be used for basic sizes less than or equal to 1 mm.

2) For tolerance classes js7 to js11, if the IT value number, n, is an odd number, this may be rounded to the even number immediately below, so that the resulting deviations, i.e. $\pm \frac{IT_n}{2}$, can be expressed in whole micrometres.

fundamental deviations of shafts

Fundamental deviation values in micrometres

deviation values

Lower deviation *ei*															
IT4 to IT7	Up to IT3 (incl.) and above IT7	All standard tolerance grades													
k		m	n	p	r	s	t	u	v	x	y	z	za	zb	zc
0	0	+ 2	+ 4	+ 6	+ 10	+ 14		+ 18		+ 20		+ 26	+ 32	+ 40	+ 60
+ 1	0	+ 4	+ 8	+ 12	+ 15	+ 19		+ 23		+ 28		+ 35	+ 42	+ 50	+ 80
+ 1	0	+ 6	+ 10	+ 15	+ 19	+ 23		+ 28		+ 34		+ 42	+ 52	+ 67	+ 97
+ 1	0	+ 7	+ 12	+ 18	+ 23	+ 28		+ 33		+ 40		+ 50	+ 64	+ 90	+ 130
									+ 39	+ 45		+ 60	+ 77	+ 108	+ 150
+ 2	0	+ 8	+ 15	+ 22	+ 28	+ 35		+ 41	+ 47	+ 54	+ 63	+ 73	+ 98	+ 136	+ 188
							+ 41	+ 48	+ 55	+ 64	+ 75	+ 88	+ 118	+ 160	+ 218
+ 2	0	+ 9	+ 17	+ 26	+ 34	+ 43	+ 48	+ 60	+ 68	+ 80	+ 94	+ 112	+ 148	+ 200	+ 274
							+ 54	+ 70	+ 81	+ 97	+ 114	+ 136	+ 180	+ 242	+ 325
+ 2	0	+ 11	+ 20	+ 32	+ 41	+ 53	+ 66	+ 87	+ 102	+ 122	+ 144	+ 172	+ 226	+ 300	+ 405
					+ 43	+ 59	+ 75	+ 102	+ 120	+ 146	+ 174	+ 210	+ 274	+ 360	+ 480
+ 3	0	+ 13	+ 23	+ 37	+ 51	+ 71	+ 91	+ 124	+ 146	+ 178	+ 214	+ 258	+ 335	+ 445	+ 585
					+ 54	+ 79	+ 104	+ 144	+ 172	+ 210	+ 254	+ 310	+ 400	+ 525	+ 690
+ 3	0	+ 15	+ 27	+ 43	+ 63	+ 92	+ 122	+ 170	+ 202	+ 248	+ 300	+ 365	+ 470	+ 620	+ 800
					+ 65	+ 100	+ 134	+ 190	+ 228	+ 280	+ 340	+ 415	+ 535	+ 700	+ 900
					+ 68	+ 108	+ 146	+ 210	+ 252	+ 310	+ 380	+ 465	+ 600	+ 780	+ 1 000
+ 4	0	+ 17	+ 31	+ 50	+ 77	+ 122	+ 166	+ 236	+ 284	+ 350	+ 425	+ 520	+ 670	+ 880	+ 1 150
					+ 80	+ 130	+ 180	+ 258	+ 310	+ 385	+ 470	+ 575	+ 740	+ 960	+ 1 250
					+ 84	+ 140	+ 196	+ 284	+ 340	+ 425	+ 520	+ 640	+ 820	+ 1 050	+ 1 350
+ 4	0	+ 20	+ 34	+ 56	+ 94	+ 158	+ 218	+ 315	+ 385	+ 475	+ 580	+ 710	+ 920	+ 1 200	+ 1 550
					+ 98	+ 170	+ 240	+ 350	+ 425	+ 525	+ 650	+ 790	+ 1 000	+ 1 300	+ 1 700
+ 4	0	+ 21	+ 37	+ 62	+ 108	+ 190	+ 268	+ 390	+ 475	+ 590	+ 730	+ 900	+ 1 150	+ 1 500	+ 1 900
					+ 114	+ 208	+ 294	+ 435	+ 530	+ 660	+ 820	+ 1 000	+ 1 300	+ 1 650	+ 2 100
+ 5	0	+ 23	+ 40	+ 68	+ 126	+ 232	+ 330	+ 490	+ 595	+ 740	+ 920	+ 1 100	+ 1 450	+ 1 850	+ 2 400
					+ 132	+ 252	+ 360	+ 540	+ 660	+ 820	+ 1 000	+ 1 250	+ 1 600	+ 2 100	+ 2 600
0	0	+ 26	+ 44	+ 78	+ 150	+ 280	+ 400	+ 600							
					+ 155	+ 310	+ 450	+ 660							
0	0	+ 30	+ 50	+ 88	+ 175	+ 340	+ 500	+ 740							
					+ 185	+ 380	+ 560	+ 840							
0	0	+ 34	+ 56	+ 100	+ 210	+ 430	+ 620	+ 940							
					+ 220	+ 470	+ 680	+ 1 050							
0	0	+ 40	+ 66	+ 120	+ 250	+ 520	+ 780	+ 1 150							
					+ 260	+ 580	+ 840	+ 1 300							
0	0	+ 48	+ 78	+ 140	+ 300	+ 640	+ 960	+ 1 450							
					+ 330	+ 720	+ 1 050	+ 1 600							
0	0	+ 58	+ 92	+ 170	+ 370	+ 820	+ 1 200	+ 1 850							
					+ 400	+ 920	+ 1 350	+ 2 000							
0	0	+ 68	+ 110	+ 195	+ 440	+ 1 000	+ 1 500	+ 2 300							
					+ 460	+ 1 100	+ 1 650	+ 2 500							
0	0	+ 76	+ 135	+ 240	+ 550	+ 1 250	+ 1 900	+ 2 900							
					+ 580	+ 1 400	+ 2 100	+ 3 200							

Table 3 — Numerical values of the

Basic size mm		Lower deviation EI											Fundamental deviation						
		All standard tolerance grades											IT6	IT7	IT8	Up to IT8 (incl.)	Above IT8	Up to IT8 (incl.)	Above IT8
Above	Up to and including	A [1]	B [1]	C	CD	D	E	EF	F	FG	G	H	JS [2]	J			K [3]		M [3] [4]	
–	3 [1] [5]	+ 270	+ 140	+ 60	+ 34	+ 20	+ 14	+ 10	+ 6	+ 4	+ 2	0	Deviations = $\pm \frac{IT_n}{2}$, where n is the IT value number	+ 2	+ 4	+ 6	0	0	− 2	− 2
3	6	+ 270	+ 140	+ 70	+ 46	+ 30	+ 20	+ 14	+ 10	+ 6	+ 4	0		+ 5	+ 6	+ 10	− 1 + Δ		− 4 + Δ	− 4
6	10	+ 280	+ 150	+ 80	+ 56	+ 40	+ 25	+ 18	+ 13	+ 8	+ 5	0		+ 5	+ 8	+ 12	− 1 + Δ		− 6 + Δ	− 6
10	14	+ 290	+ 150	+ 95		+ 50	+ 32		+ 16		+ 6	0		+ 6	+ 10	+ 15	− 1 + Δ		− 7 + Δ	− 7
14	18																			
18	24	+ 300	+ 160	+ 110		+ 65	+ 40		+ 20		+ 7	0		+ 8	+ 12	+ 20	− 2 + Δ		− 8 + Δ	− 8
24	30																			
30	40	+ 310	+ 170	+ 120		+ 80	+ 50		+ 25		+ 9	0		+ 10	+ 14	+ 24	− 2 + Δ		− 9 + Δ	− 9
40	50	+ 320	+ 180	+ 130																
50	65	+ 340	+ 190	+ 140		+ 100	+ 60		+ 30		+ 10	0		+ 13	+ 18	+ 28	− 2 + Δ		− 11 + Δ	− 11
65	80	+ 360	+ 200	+ 150																
80	100	+ 380	+ 220	+ 170		+ 120	+ 72		+ 36		+ 12	0		+ 16	+ 22	+ 34	− 3 + Δ		− 13 + Δ	− 13
100	120	+ 410	+ 240	+ 180																
120	140	+ 460	+ 260	+ 200		+ 145	+ 85		+ 43		+ 14	0		+ 18	+ 26	+ 41	− 3 + Δ		− 15 + Δ	− 15
140	160	+ 520	+ 280	+ 210																
160	180	+ 580	+ 310	+ 230																
180	200	+ 660	+ 340	+ 240		+ 170	+ 100		+ 50		+ 15	0		+ 22	+ 30	+ 47	− 4 + Δ		− 17 + Δ	− 17
200	225	+ 740	+ 380	+ 260																
225	250	+ 820	+ 420	+ 280																
250	280	+ 920	+ 480	+ 300		+ 190	+ 110		+ 56		+ 17	0		+ 25	+ 36	+ 55	− 4 + Δ		− 20 + Δ	− 20
280	315	+ 1 050	+ 540	+ 330																
315	355	+ 1 200	+ 600	+ 360		+ 210	+ 125		+ 62		+ 18	0		+ 29	+ 39	+ 60	− 4 + Δ		− 21 + Δ	− 21
355	400	+ 1 350	+ 680	+ 400																
400	450	+ 1 500	+ 760	+ 440		+ 230	+ 135		+ 68		+ 20	0		+ 33	+ 43	+ 66	− 5 + Δ		− 23 + Δ	− 23
450	500	+ 1 650	+ 840	+ 480																
500	560					+ 260	+ 145		+ 76		+ 22	0					0		− 26	
560	630																			
630	710					+ 290	+ 160		+ 80		+ 24	0					0		− 30	
710	800																			
800	900					+ 320	+ 170		+ 86		+ 26	0					0		− 34	
900	1 000																			
1 000	1 120					+ 350	+ 195		+ 98		+ 28	0					0		− 40	
1 120	1 250																			
1 250	1 400					+ 390	+ 220		+ 110		+ 30	0					0		− 48	
1 400	1 600																			
1 600	1 800					+ 430	+ 240		+ 120		+ 32	0					0		− 58	
1 800	2 000																			
2 000	2 240					+ 480	+ 260		+ 130		+ 34	0					0		− 68	
2 240	2 500																			
2 500	2 800					+ 520	+ 290		+ 145		+ 38	0					0		− 76	
2 800	3 150																			

1) Fundamental deviations A and B shall not be used for basic sizes less than or equal to 1 mm.

2) For tolerance classes JS7 to JS11, if the IT value number, n, is an odd number, this may be rounded to the even number immediately below, so that the resulting deviations, i.e. $\pm \frac{IT_n}{2}$, can be expressed in whole micrometres.

3) For determining the values K, M and N for standard tolerance grades up to IT8 (incl.) and deviations P to ZC for standard tolerance grades up to IT7 (incl.), take the Δ values from the columns on the right.

fundamental deviations of holes

Fundamental deviation values in micrometres

values			Upper deviation ES												Values for Δ					
Up to IT8 (incl.)	Above IT8	Up to IT7 (incl.)	Standard tolerance grades above IT7												Standard tolerance grades					
N[3)5)]		P to ZC[3)]	P	R	S	T	U	V	X	Y	Z	ZA	ZB	ZC	IT3	IT4	IT5	IT6	IT7	IT8
−4	−4	Values as for standard tolerance grades above IT7 increased by Δ	−6	−10	−14		−18		−20		−26	−32	−40	−60	0	0	0	0	0	0
−8 + Δ	0		−12	−15	−19		−23		−28		−35	−42	−50	−80	1	1,5	1	3	4	6
−10 + Δ	0		−15	−19	−23		−28		−34		−42	−52	−67	−97	1	1,5	2	3	6	7
−12 + Δ	0		−18	−23	−28		−33		−40		−50	−64	−90	−130	1	2	3	3	7	9
								−39	−45		−60	−77	−108	−150						
−15 + Δ	0		−22	−28	−35		−41	−47	−54	−63	−73	−98	−136	−188	1,5	2	3	4	8	12
						−41	−48	−55	−64	−75	−88	−118	−160	−218						
−17 + Δ	0		−26	−34	−43	−48	−60	−68	−80	−94	−112	−148	−200	−274	1,5	3	4	5	9	14
						−54	−70	−81	−97	−114	−136	−180	−242	−325						
−20 + Δ	0		−32	−41	−53	−66	−87	−102	−122	−144	−172	−226	−300	−405	2	3	5	6	11	16
				−43	−59	−75	−102	−120	−146	−174	−210	−274	−360	−480						
−23 + Δ	0		−37	−51	−71	−91	−124	−146	−178	−214	−258	−335	−445	−585	2	4	5	7	13	19
				−54	−79	−104	−144	−172	−210	−254	−310	−400	−525	−690						
−27 + Δ	0		−43	−63	−92	−122	−170	−202	−248	−300	−365	−470	−620	−800	3	4	6	7	15	23
				−65	−100	−134	−190	−228	−280	−340	−415	−535	−700	−900						
				−68	−108	−146	−210	−252	−310	−380	−465	−600	−780	−1 000						
−31 + Δ	0		−50	−77	−122	−166	−236	−284	−350	−425	−520	−670	−880	−1 150	3	4	6	9	17	26
				−80	−130	−180	−258	−310	−385	−470	−575	−740	−960	−1 250						
				−84	−140	−196	−284	−340	−425	−520	−640	−820	−1 050	−1 350						
−34 + Δ	0		−56	−94	−158	−218	−315	−385	−475	−580	−710	−920	−1 200	−1 550	4	4	7	9	20	29
				−98	−170	−240	−350	−425	−525	−650	−790	−1 000	−1 300	−1 700						
−37 + Δ	0		−62	−108	−190	−268	−390	−475	−590	−730	−900	−1 150	−1 500	−1 900	4	5	7	11	21	32
				−114	−208	−294	−435	−530	−660	−820	−1 000	−1 300	−1 650	−2 100						
−40 + Δ	0		−68	−126	−232	−330	−490	−595	−740	−920	−1 100	−1 450	−1 850	−2 400	5	5	7	13	23	34
				−132	−252	−360	−540	−660	−820	−1 000	−1 250	−1 600	−2 100	−2 600						
−44			−78	−150	−280	−400	−600													
				−155	−310	−450	−660													
−50			−88	−175	−340	−500	−740													
				−185	−380	−560	−840													
−56			−100	−210	−430	−620	−940													
				−220	−470	−680	−1 050													
−66			−120	−250	−520	−780	−1 150													
				−260	−580	−840	−1 300													
−78			−140	−300	−640	−960	−1 450													
				−330	−720	−1 050	−1 600													
−92			−170	−370	−820	−1 200	−1 850													
				−400	−920	−1 350	−2 000													
−110			−195	−440	−1 000	−1 500	−2 300													
				−460	−1 100	−1 650	−2 500													
−135			−240	−550	−1 250	−1 900	−2 900													
				−580	−1 400	−2 100	−3 200													

3) (*concl.*) *Examples:*

K7 in the range 18 to 30 mm: Δ = 8 µm, therefore ES = −2 + 8 = +6 µm

S6 in the range 18 to 30 mm: Δ = 4 µm, therefore ES = −35 + 4 = −31 µm

4) Special cases: for tolerance class M6 in the range from 250 to 315 mm, ES = −9 µm (instead of −11 µm).

5) Fundamental deviation N for standard tolerance grades above IT8 shall not be used for basic sizes less than or equal to 1 mm.

10 Bibliography

The following International Standards on tolerancing and tolerance systems will be useful with regard to the application of this part of ISO 286:

ISO 406, *Technical drawings — Linear and angular tolerances — Indications on drawings.*

ISO 1101, *Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out — Generalities, definitions, symbols, indications on drawings.*

ISO 1829, *Selection of tolerance zones for general purposes.*

ISO 1947, *System of cone tolerances for conical workpieces from* C = 1 : 3 *to* 1 : 500 *and lengths from* 6 *to* 630 mm.

ISO 2692, *Technical drawings — Geometrical tolerancing — Maximum material principle.*

ISO 2768-1, *General tolerances for dimensions without tolerance indications — Part 1: Tolerances for linear and angular dimensions.*[1)]

ISO 5166, *System of cone fits for cones from* C = 1 : 3 *to* 1 : 500, *lengths from* 6 *to* 630 mm *and diameters up to* 500 mm.

1) At present at the stage of draft. (Revision, in part, of ISO 2768 : 1973.)

Annex A

Bases of the ISO system of limits and fits

(This annex forms an integral part of the standard.)

A.1 General

This annex gives the bases of the ISO system of limits and fits. The data are given primarily so that values can be calculated for fundamental deviations, which may be required in very special circumstances and which are not given in the tables, and also so that a more complete understanding of the system is provided.

It is once more emphasized that the tabulated values in either this part of ISO 286 or ISO 286-2, for standard tolerances and fundamental deviations, are definitive, and shall be used when applying the system.

A.2 Basic size steps

For convenience, the standard tolerances and fundamental deviations are not calculated individually for each separate basic size, but for steps of the basic size as given in table 4. These steps are grouped into main steps and intermediate steps. The intermediate steps are only used in certain cases for calculating standard tolerances and fundamental deviations a to c and r to zc for shafts, and A to C and R to ZC for holes.

The values of the standard tolerances and fundamental deviations for each basic size step are calculated from the

Table 4 — Basic size steps

Values in millimetres

a) Basic sizes up to 500 mm (incl.)			
Main steps		**Intermediate steps**[1]	
Above	Up to and including	Above	Up to and including
—	3	No subdivision	
3	6		
6	10		
10	18	10 14	14 18
18	30	18 24	24 30
30	50	30 40	40 50
50	80	50 65	65 80
80	120	80 100	100 120
120	180	120 140 160	140 160 180
180	250	180 200 225	200 225 250
250	315	250 280	280 315
315	400	315 355	355 400
400	500	400 450	450 500

Values in millimetres

b) Basic sizes above 500 mm up to 3 150 mm (incl.)			
Main steps		**Intermediate steps**[2]	
Above	Up to and including	Above	Up to and including
500	630	500 560	560 630
630	800	630 710	710 800
800	1 000	800 900	900 1 000
1 000	1 250	1 000 1 120	1 120 1 250
1 250	1 600	1 250 1 400	1 400 1 600
1 600	2 000	1 600 1 800	1 800 2 000
2 000	2 500	2 000 2 240	2 240 2 500
2 500	3 150	2 500 2 800	2 800 3 150

1) These are used, in certain cases, for deviations a to c and r to zc or A to C and R to ZC (see tables 2 and 3).

2) These are used for the deviations r to u and R to U (see tables 2 and 3).

geometrical mean (D) of the extreme sizes (D_1 and D_2) of that step, as follows:

$$D = \sqrt{D_1 \times D_2}$$

For the first basic size step (less than or equal to 3 mm), the geometrical mean, D, according to convention, is taken between the sizes 1 and 3 mm, therefore D = 1,732 mm.

A.3 Standard tolerance grades

A.3.1 General

The ISO system of limits and fits provides for 20 standard tolerance grades designated IT01, IT0, IT1, . . . , IT18 in the size range from 0 up to 500 mm (incl.), and 18 standard tolerance grades in the size range from 500 mm up to 3 150 mm (incl.), designated IT1 to IT18.

As stated in the "Foreword", the ISO system is derived from ISA Bulletin 25, which only covered basic sizes up to 500 mm, and was mainly based on practical experience in industry. The system was not developed from a coherent mathematical base, and hence there are discontinuities in the system and differing formulae for the deviation of IT grades up to 500 mm.

The values for standard tolerances for basic sizes from 500 mm up to 3 150 mm (incl.) were subsequently developed for experimental purposes, and since they have proved acceptable to industry they are now given as a part of the ISO system.

It should be noted that values for standard tolerances in grades IT0 and IT01 are not given in the main body of the standard because they have little use in practice; however, values for these are given in table 5.

Table 5 — Numerical values for standard tolerances in grades IT01 and IT0

Basic size		Standard tolerance grades	
mm		IT01	IT0
Above	Up to and including	Tolerances μm	
—	3	0,3	0,5
3	6	0,4	0,6
6	10	0,4	0,6
10	18	0,5	0,8
18	30	0,6	1
30	50	0,6	1
50	80	0,8	1,2
80	120	1	1,5
120	180	1,2	2
180	250	2	3
250	315	2,5	4
315	400	3	5
400	500	4	6

A.3.2 Derivation of standard tolerances (IT) for basic sizes up to and including 500 mm

A.3.2.1 Standard tolerance grades IT01 to IT4

The values of standard tolerances in grades IT01, IT0 and IT1 are calculated from the formulae given in table 6. It should be noted that no formulae are given for grades IT2, IT3 and IT4. The values for tolerances in these grades have been approximately scaled in geometrical progression between the values for IT1 and IT5.

Table 6 — Formulae for standard tolerances in grades IT01, IT0 and IT1 for basic sizes up to and including 500 mm

Values in micrometres

Standard tolerance grade	Formula for calculation where D is the geometric mean of the basic size in millimetres
IT01 [1]	$0,3 + 0,008D$
IT0 [1]	$0,5 + 0,012D$
IT1	$0,8 + 0,020D$

1) See the "Foreword" and A.3.1.

A.3.2.2 Standard tolerance grades IT5 to IT18

The values for standard tolerances in grades IT5 to IT18 for basic sizes up to and including 500 mm are determined as a function of the standard tolerance factor, i.

The standard tolerance factor, i, in micrometres, is calculated from the following formula:

$$i = 0,45 \sqrt[3]{D} + 0,001D$$

where D is the geometric mean of the basic size step in millimetres (see clause A.2).

This formula was empirically derived, being based on various national practices and on the premise that, for the same manufacturing process, the relationship between the magnitude of the manufacturing errors and the basic size approximates a parabolic function.

The values of the standard tolerances are calculated in terms of the standard tolerance factor, i, as shown in table 7.

It should be noted that from IT6 upwards, the standard tolerances are multiplied by a factor of 10 at each fifth step. This rule applies to all standard tolerances and may be used to extrapolate values for IT grades above IT18.

Example:

$$IT20 = IT15 \times 10 = 640i \times 10 = 6\,400i$$

NOTE — The above rule applies except for IT6 in the basic size range from 3 to 6 mm (incl.).

Table 7 — Formulae for standard tolerances in grades IT1 to IT18

Basic size mm		Standard tolerance grades																	
		IT1[1]	IT2[1]	IT3[1]	IT4[1]	IT5	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13	IT14	IT15	IT16	IT17	IT18
Above	Up to and including	Formulae for standard tolerances (Results in micrometres)																	
—	500	—	—	—	—	7*i*	10*i*	16*i*	25*i*	40*i*	64*i*	100*i*	160*i*	250*i*	400*i*	640*i*	1000*i*	1600*i*	2500*i*
500	3 150	2*I*	2,7*I*	3,7*I*	5*I*	7*I*	10*I*	16*I*	25*I*	40*I*	64*I*	100*I*	160*I*	250*I*	400*I*	640*I*	1000*I*	1600*I*	2500*I*

1) See A.3.2.1.

A.3.3 Derivation of standard tolerances (IT) for basic sizes from 500 mm up to and including 3 150 mm

The values for standard tolerances in grades IT1 to IT18 are determined as a function of the standard tolerance factor, I.

The standard tolerance factor, I, in micrometres, is calculated from the following formula:

$$I = 0{,}004D + 2{,}1$$

where D is the geometric mean of the basic size step in millimetres (see clause A.2).

The values of the standard tolerances are calculated in terms of the standard tolerance factor, I, as shown in table 7.

It should be noted that from IT6 upwards, the standard tolerances are multiplied by a factor of 10 at each fifth step. This rule applies to all standard tolerances and may be used to extrapolate values for IT grades above IT18.

Example:

$$\text{IT20} = \text{IT15} \times 10 = 640I \times 10 = 6\,400I$$

NOTES

1 The formulae for standard tolerances in grades IT1 to IT5 are given on a provisional basis only. (These did not appear in ISO/R 286 : 1962.)

2 Although the formulae for i and I vary, continuity of progression is assured for the transition range.

A.3.4 Rounding of values for standard tolerances

For each basic size step, the values obtained from the formulae given in A.3.2 and A.3.3, for standard tolerances in grades up to and including IT11, are rounded off in accordance with the rules given in table 8.

The calculated values of standard tolerances in grades above IT11 do not require rounding off because they are derived from values of tolerance grades IT7 to IT11, which have already been rounded off.

Table 8 — Rounding for IT values up to and including standard tolerance grade IT11

Rounding values in micrometres

Calculated values obtained from the formulae given in A.3.2 and A.3.3		Basic size	
		Up to 500 mm (incl.)	Above 500 mm up to 3 150 mm (incl.)
Above	Up to and including	Rounding in multiples of	
0	60	1	1
60	100	1	2
100	200	5	5
200	500	10	10
500	1 000	—	20
1 000	2 000	—	50
2 000	5 000	—	100
5 000	10 000	—	200
10 000	20 000	—	500
20 000	50 000	—	1 000

NOTES

1 For the small values in particular, it has sometimes been necessary to depart from these rules, and, in some instances, even from the application of the formulae given in A.3.2 and A.3.3 in order to ensure better scaling. Therefore the values given for the standard tolerances in tables 1 and 5, as appropriate, shall be used in preference to calculated values when applying the ISO system.

2 Values for standard tolerances in grades IT1 to IT18 are given in table 1 and for IT0 and IT01 in table 5.

A.4 Derivation of fundamental deviations

A.4.1 Fundamental deviations for shafts

The fundamental deviations for shafts are calculated from the formulae given in table 9.

The fundamental deviation given by the formulae in table 9 is, in principle, that corresponding to the limits closest to the zero line, i.e. the upper deviation for shafts a to h and the lower deviation for shafts k to zc.

Except for shafts j and js, for which, strictly speaking, there is no fundamental deviation, the value of the deviation is independent of the selected grade of tolerance (even if the formula includes a term involving IT*n*).

A.4.2 Fundamental deviations for holes

The fundamental deviations for holes are calculated from the formulae given in table 9 and, therefore, the limit corresponding to the fundamental deviation for a hole is exactly symmetrical, in relation to the zero line, to the limit corresponding to the fundamental deviation for a shaft with the same letter.

This rule applies to all fundamental deviations except for the following:

a) deviation N, for standard tolerance grades IT9 to IT16 in basic sizes above 3 mm up to 500 mm (incl.), for which the fundamental deviation is zero;

b) shaft or hole basis fits, for basic sizes above 3 up to 500 mm (incl.), in which a hole of a given standard tolerance grade is associated with a shaft of the next finer grade (e.g. H7/p6 and P7/h6), and which are required to have exactly the same clearance or interferences, see figure 20.

In these cases, the fundamental deviation, as calculated, is adjusted by algebraically adding the value of Δ as follows:

$ES = ES$ (as calculated) $+ \Delta$

where Δ is the difference ITn − IT(n − 1) between the standard tolerance, for the basic size step in the given grade, and that in the next finer grade.

Example:

For P7 in the basic size range from 18 up to 30 mm:

Δ = IT7 − IT6 = 21 − 13 = 8 µm

NOTE — The rule given in b) above is only applicable for basic sizes over 3 mm for fundamental deviations K, M and N in standard tolerance grades up to and including IT8, and deviations P to ZC in standard tolerance grades up to and including IT7.

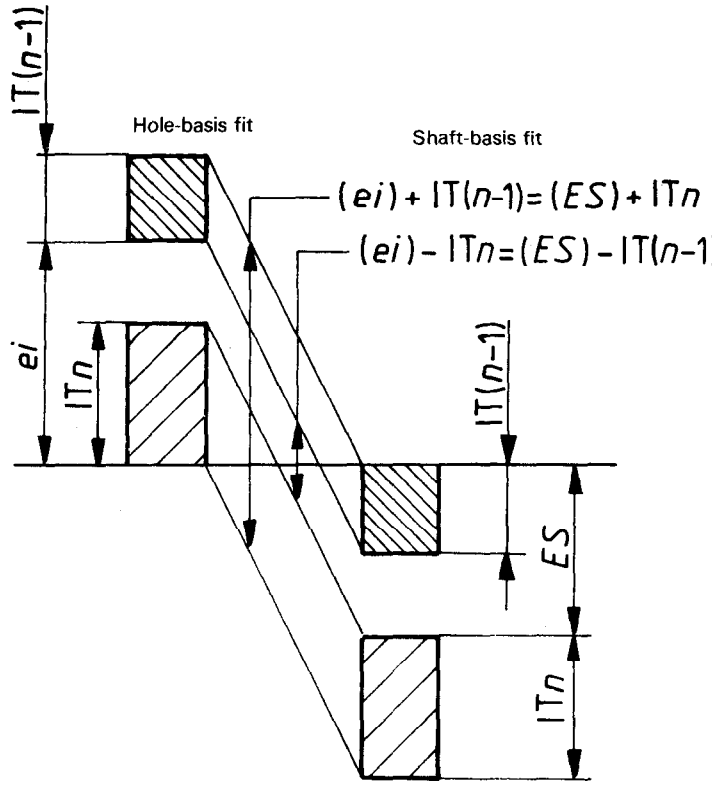


Figure 20 — Diagrammatic representation of the rule given in A.4.2b)

The fundamental deviation given by the formulae in table 9 is, in principle, that corresponding to the limits closest to the zero line, i.e. the lower deviation for holes A to H and the upper deviation for holes K to ZC.

Except for holes J and JS, for which, strictly speaking, there is no fundamental deviation, the value of the deviation is independent of the selected grade of tolerance (even if the formula includes a term involving IT*n*).

A.4.3 Rounding of values for fundamental deviations

For each basic size step, the values obtained from the formulae given in table 9 are rounded off in accordance with the rules given in table 10.

Table 9 — Formulae for fundamental deviations for shafts and holes

Basic size mm		Shafts			Formulae[1] where D is the geometric mean of the basic size in millimetres	Holes			Basic size mm	
Above	Up to and including	Fundamental deviation	Sign (negative or positive)	Designation		Designation	Sign (negative or positive)	Fundamental deviation	Above	Up to and including
1	120	a	−	*es*	$265 + 1{,}3D$	*EI*	+	A	1	120
120	500				$3{,}5D$				120	500
1	160	b	−	*es*	$\approx 140 + 0{,}85D$	*EI*	+	B	1	160
160	500				$\approx 1{,}8D$				160	500
0	40	c	−	*es*	$52D^{0,2}$	*EI*	+	C	0	40
40	500				$95 + 0{,}8D$				40	500
0	10	cd	−	*es*	Geometric mean of the values for C, c and D, d	*EI*	+	CD	0	10
0	3 150	d	−	*es*	$16D^{0,44}$	*EI*	+	D	0	3 150
0	3 150	e	−	*es*	$11D^{0,41}$	*EI*	+	E	0	3 150
0	10	ef	−	*es*	Geometric mean of the values for E, e and F, f	*EI*	+	EF	0	10
0	3 150	f	−	*es*	$5{,}5D^{0,41}$	*EI*	+	F	0	3 150
0	10	fg	−	*es*	Geometric mean of the values for F, f and G, g	*EI*	+	FG	0	10
0	3 150	g	−	*es*	$2{,}5D^{0,34}$	*EI*	+	G	0	3 150
0	3 150	h	No sign	*es*	Deviation = 0	*EI*	No sign	H	0	3 150
0	500	j			No formula[2]			J	0	500
0	3 150	js	+ or −	*es* or *ei*	$0{,}5\ IT_n$	*EI* or *ES*	+ or −	JS	0	3 150
0	500[3]	k	+	*ei*	$0{,}6\sqrt[3]{D}$	*ES*	−	K[4]	0	500[5]
500	3 150		No sign		Deviation = 0		No sign		500	3 150
0	500	m	+	*ei*	IT7 − IT6	*ES*	−	M[4]	0	500
500	3 150				$0{,}024D + 12{,}6$				500	3 150
0	500	n	+	*ei*	$5D^{0,34}$	*ES*	−	N[4]	0	500
500	3 150				$0{,}04D + 21$				500	3 150
0	500	p	+	*ei*	IT7 + 0 to 5	*ES*	−	P[4]	0	500
500	3 150				$0{,}072D + 37{,}8$				500	3 150
0	3 150	r	+	*ei*	Geometric mean of the values for P, p and S, s	*ES*	−	R[4]	0	3 150
0	50	s	+	*ei*	IT8 + 1 to 4	*ES*	−	S[4]	0	50
50	3 150				IT7 + 0,4*D*				50	3 150
24	3 150	t	+	*ei*	IT7 + 0,63*D*	*ES*	−	T[4]	24	3 150
0	3 150	u	+	*ei*	IT7 + *D*	*ES*	−	U[4]	0	3 150
14	500	v	+	*ei*	IT7 + 1,25*D*	*ES*	−	V[4]	14	500
0	500	x	+	*ei*	IT7 + 1,6*D*	*ES*	−	X[4]	0	500
18	500	y	+	*ei*	IT7 + 2*D*	*ES*	−	Y[4]	18	500
0	500	z	+	*ei*	IT7 + 2,5*D*	*ES*	−	Z[4]	0	500
0	500	za	+	*ei*	IT8 + 3,15*D*	*ES*	−	ZA[4]	0	500
0	500	zb	+	*ei*	IT9 + 4*D*	*ES*	−	ZB[4]	0	500
0	500	zc	+	*ei*	IT10 + 5*D*	*ES*	−	ZC[4]	0	500

1) Fundamental deviations (i.e. results from formulae) in micrometres.

2) Values only given in tables 2 and 3.

3) Formula only applies to grades IT4 to IT7 inclusively; fundamental deviation k for all other basic sizes and all other IT grades = 0.

4) Special rule applies [see A.4.2b)].

5) Formula only applies to grades up to IT8 inclusively; fundamental deviation K for all other basic sizes and all other IT grades = 0.

Table 10 — Rounding for fundamental deviations

Rounding values in micrometres

Calculated values obtained from the formulae given in table 9 µm		Basic size		
		up to 500 mm (incl.)		above 500 mm up to 3 150 mm (incl.)
		Fundamental deviations		
		a to g A to G	k to zc K to ZC	d to u D to U
Above	Up to and including	Rounding in multiples of		
5	45	1	1	1
45	60	2	1	1
60	100	5	1	2
100	200	5	2	5
200	300	10	2	10
300	500	10	5	10
500	560	10	5	20
560	600	20	5	20
600	800	20	10	20
800	1 000	20	20	20
1 000	2 000	50	50	50
2 000	5 000		100	100
. . .	. . .			. . .
20×10^n	50×10^n			1×10^n
50×10^n	100×10^n			2×10^n
100×10^n	200×10^n			5×10^n

Annex B

Examples of the use of ISO 286-1

(This annex forms an integral part of the standard.)

B.1 General

This annex gives examples in the use of the ISO system of limits and fits, in determining the limits for shafts and holes.

The numerical values of the upper and lower deviations for the more generally used basic size steps, fundamental deviations and tolerance grades have been calculated and are tabulated in ISO 286-2.

In special cases, not covered by ISO 286-2, the appropriate upper and lower deviations, and hence the limits of size, can be calculated from the data given in tables 1 to 3, and tables 4 to 6 in annex A in this part of ISO 286.

B.2 Review of special features

A summary of the features and factors which shall be taken into consideration when using this part of ISO 286 to derive upper and lower deviations for special cases is given below:

— shafts and holes a, A, b, B are provided only for basic sizes greater than 1 mm;

— shafts j8 are provided only for basic sizes less than or equal to 3 mm;

— holes K in tolerance grades above IT8 are provided only for basic sizes less than or equal to 3 mm;

— shafts and holes t, T, v, V and y, Y are only provided for basic sizes greater than 24 mm, 14 mm and 18 mm, respectively (for smaller basic sizes, the deviations are practically the same as those of the adjacent tolerance grades);

— tolerance grades IT14 to IT18 are only provided for basic sizes greater than 1 mm;

— holes N of tolerance grades above IT8 are only provided for basic sizes greater than 1 mm.

B.3 Examples

B.3.1 Determining the limits of size for a shaft ø 40g11

Basic size step: 30 to 50 mm (from table 4)

Standard tolerance = 160 µm (from table 1)

Fundamental deviation = −9 µm (from table 2)

Upper deviation = fundamental deviation = −9 µm

Lower deviation = fundamental deviation − tolerance
= −9 − 160 µm = − 169 µm

Limits of size:

Maximum = 40 − 0,009 = 39,991 mm

Minimum = 40 − 0,169 = 39,831 mm

B.3.2 Determining the limits of size for a hole ø 130N4

Basic size step: 120 to 180 mm (from table 4)

Standard tolerance = 12 µm (from table 1)

Fundamental deviation = $-27 + \Delta$ µm (from table 3)

Value of Δ = 4 µm (from table 3)

Upper deviation = fundamental deviation
= −27 + 4 = −23 µm

Lower deviation = fundamental deviation − tolerance
= −23 − 12 µm = −35 µm

Limits of size:

Maximum = 130 − 0,023 = 129,977 mm

Minimum = 130 − 0,035 = 129,965 mm

Annex C

Equivalent terms

(This annex does not form an integral part of the standard.)

C.1 General

This annex establishes a list of terms used in ISO 286 (and in other International Standards on tolerances).

NOTE — In addition to terms used in the three official ISO languages (English, French and Russian), the equivalent terms in German, Spanish, Italian, Swedish and Japanese are also given. These have been included at the request of Technical Committee ISO/TC 3 and are published under the responsibility of the member bodies for Germany, F.R. (DIN), Spain (AENOR), Italy (UNI), Sweden (SIS) and Japan (JISC).

C.2 Notes on presentation

The numerals 01 to 90 give the alphabetical order for the first language (i.e. English) only (for reference).

The column "Reference clause" refers to the number of the clause, sub-clause, etc. in which the term is defined (or the most important place) in this part of ISO 286.

The words given in "parentheses" indicate that the part of the term placed between them may be omitted.

Synonyms have been separated by a semi-colon. Square brackets indicate that the word(s) placed between them may replace all or some of the preceding words.

Short explanations as regards the term have been presented in note form.

C.3 Recommendations for the user

It is recommended that the users, for convenience, re-arrange the vocabulary alphabetically in their own languages and number them accordingly on the left-hand side of the table.

Reference No.	English	French	Russian	German	Spanish	Italian	Swedish	Japanese	Reference clause
01	accuracy grade	degré de précision	степень точности	Genauigkeitsgrad	grado de precisión	grado di precisione	noggrannhetsgrad	—	—
02	actual clearance	jeu effectif	действительный зазор	Istspiel	juego efectivo o real	giuoco effettivo	verkligt spel	—	—
03	actual deviation	écart effectif	действительное отклонение	Istabmaß	desviación efectiva o real	scostamento effettivo	verkligt avmått	—	—
04	actual interference	serrage effectif	действительный натяг	Istübermaß	aprieto efectivo o real	interferenza effettiva	verkligt grepp	—	—
05	actual size	dimension effective	действительный размер	Istmaß	medida efectiva o real	dimensione effettiva	verkligt mått	実寸法	4.3.2
06	approximate size	dimension approximative	приблизительный размер	Ungefährmaß	medida aproximada	dimensione approssimativa	ungefärligt mått; cirkamått	—	—
07	basic size; nominal size	dimension nominale	номинальный размер	Nennmaß	medida nominal	dimensione nominale	basmått; nominellt mått	基準寸法	4.3.1
08	character of fit	caractère d'ajustement	характер посадки	Passungscharakter	carácter de ajuste	carattere dell'accoppiamento	passningskaraktär	—	—
	NOTE — In verbal descriptions.	NOTE — En descriptions verbales.	ПРИМЕЧАНИЕ — Словесное описание.	ANMERKUNG — In verbalen Beschreibungen.	NOTA — En descripciones verbales.	NOTA — In descrizioni verbali.	NOT — Med verbal beskrivning.		
09	clearance	jeu	зазор	Spiel	juego	giuoco	spel	すきま	4.8
10	clearance fit	ajustement avec jeu	посадка с зазором	Spielpassung	ajuste con juego	accoppiamento con giuoco	spelpassning	すきまばめ	4.10.1
11	desired size	dimension de consigne	заданный размер	Sollmaß	medida teorica	dimensione desiderata	önskat mått	—	—
12	deviation	ecart	отклонение	Abmaß	desviación (o diferencia)	scostamento	avmått; avvikelse	寸法差	4.6
13	dimensional tolerance; size tolerance	tolérance dimensionnelle	допуск размера	Maßtoleranz	tolerancia dimensional	tolleranza dimensionale	dimensionstolerans; måttolerans	寸法公差	4.7
14	envelope requirement	exigence de l'enveloppe	требования к покрытию	Hüllbedingung	condición del envolvente	condizione del inviluppamento	enveloppkrav	包絡の条件	5.3.1.2
15	external [outer] part [component] of fit	élément extérieur [femelle] d'un ajustement	наружная сопрягаемая деталь	äußeres Paßteil; Außenpaßteil	elemento [pieza] exterior de un ajuste	pezzo esterno di un accoppiamento	utvändig passningsdel	外側形体	See No. 64

Reference No.	English	French	Russian	German	Spanish	Italian	Swedish	Japanese	Reference clause
16	fit	ajustement	посадка	Passung	ajuste	accoppiamento	passning	はめあい	4.10
17	fit component [part]	élément d'un ajustement	сопрягаемая деталь	Paßteil	elemento [pieza] de un ajuste	elemento [pezzo] di un accoppiamento	passningsdel	–	–
18	fit surface; mating surface	surface d'ajustement	сопрягаемая поверхность	Paßfläche	superficie de un ajuste	superficie di accoppiamento	passningsyta	–	–
19	fit tolerance; variation of fit	tolérance d'ajustement	допуск посадки	Paßtoleranz	tolerancia de ajuste	tolleranza d'accoppiamento	passningens toleransvidd; passningsvariation	はめあいの変動量	4.10.4
20	fit tolerance zone; variation zone	zone de tolérance d'ajustement	поле допуска посадки	Paßtoleranzfeld	zona de tolerancia de ajuste	zona di tolleranza di accoppiamento	passningens toleransområde	–	–
21	fit symbol	symbole de l'ajustement	условное обозначение посадки	Passungssymbol; Passungskurzzeichen	simbolo de ajuste	simbolo di accoppiamento	passningssymbol	はめあいの記号	5.2.3
22	fit system	système d'ajustement	система посадок	Passungssystem; Paßsystem	sistema de ajuste	sistema di accoppiamenti	passningssystem	はめあい方式	4.11
23	fundamental deviation	écart fondamental	основное отклонение	Grundabmaß	desviación fundamental	scostamento fondamentale	lägesavmått	基礎となる寸法許容差	4.6.2
24	fundamental [standard] tolerance	tolérance fondamentale	допуск системы; стандартный допуск	Grundtoleranz	tolerancia fundamental	tolleranza fondamentale	grundtolerans; grundtoleransvidd	基本公差	4.7.1
25	general tolerance	tolérance générale	общий допуск	Allgemeintoleranz	tolerancia general	tolleranza generale	generell tolerans	–	–
26	hole	alésage	отверстие	Bohrung	agujero	foro	hål	穴	4.2
27	interference	serrage	натяг	Übermaß	aprieto	interferenza	grepp	しめしろ	4.9
28	interference fit	ajustement avec serrage	посадка с натягом	Übermaßpassung	ajuste con aprieto	accoppiamento con interferenza	greppassning	しまりばめ	4.10.2
29	internal [inner] part [component] of fit	élément intérieur [mâle] d'un ajustement	внутренняя сопрягаемая деталь	Inneres Paßteil; Innenpaßteil	elemento [pieza] interior de un ajuste	pezzo interno di accoppiamento	invändig passningsdel	内側形体	See No. 26
30	international [standard] tolerance grade (IT . . .)	degré de tolérance international [normalité] (IT . . .)	[стандартный] класс международных допусков (IT . . .)	internationaler [Standard-]Toleranzgrad (IT . . .)	grado internacional de tolerancia (IT . . .)	grado di tolleranza internazionale (IT . . .)	internationell toleransgrad; standardtoleransgrad (IT . . .)	公差等級	5.1.1 and table 1

Reference No.	English	French	Russian	German	Spanish	Italian	Swedish	Japanese	Reference clause
31	ISO fundamental [standard] tolerance series	série de tolérance internationale ISO	ряд основных допусков ИСО	ISO-Grundtoleranz-Reihe	serie de tolerancias fundamentales ISO	serie di tolleranze fondamentali ISO	ISO-grundtoleransserie	–	–
32	ISO "hole-basis" system of fits	système d'ajustements ISO « à alésage normal »	система посадок ИСО „основное отверстие"	ISO-Paßsystem „Einheitsbohrung"	sistema de ajustes ISO "agujero único" (o "agujero base")	sistema di accoppiamenti ISO "foro base"	ISO passningssystem "hålet bas"	穴基準はめあい	4.11.2
33	ISO "shaft-basis" system of fits	système d'ajustements ISO « à arbre normal »	система посадок ИСО „обычный вал"	ISO-Paßsystem „Einheitswelle"	sistema de ajustes ISO "eje único" (o "eje base")	sistema di accoppiamenti ISO "albero base"	ISO passningssystem "axeln bas"	軸基準はめあい	4.11.1
34	least material limit (LML)	dimension au minimum de matière (LMC)	предел минимума материала (*LML*)	Minimum-Material-Maß	medida de mínimo material	dimensione di minimo materiale	min. materialgräns; stoppgräns	最小実体寸法	4.13
35	limit deviations	écarts limites	предельные отклонения	Grenzabmaße	desviaciones; diferencias)	scostamenti limiti	gränsavmått; gränsavvikelse	寸法許容差	–
36	limits of fit	limites d'ajustement	предельные значения посадки	Grenzpassungen	ajustes límites	accoppiamenti limiti	gränspassningar	–	–
37	limits of size	dimensions limites	предельные размеры	Grenzmaße	medidas límites	dimensioni limiti	gränsmått	許容限界寸法	4.3.3
38	line of zero deviation; zero line	ligne d'écart nul; ligne zéro	нулевая линия; линия нулевого отклонения	Linie des Abmaßes Null; Nullinie	línea cero; línea de referencia	linea dello zero	nollinje	基準線	4.5 and figure 13
39	loosest extreme of fit	ajustement limite le plus large	наибольшая свободная посадка	Höchstpassung; weiteste Grenzpassung	ajuste límite con máximo juego	accoppiamento limite il più largo [sciolto]	största passning	–	–
40	lower deviation	écart inférieur	нижнее отклонение	unteres Abmaß	desviación inferior	scostamento inferiore	undre gränsavmått	下の寸法許容差	4.6.1.2
41	mating	appariement	сопряжение	Paarung	acoplamiento; apareamiento	connessione	tillpassning	–	–
42	mating size	dimension d'appariement	сопрягаемый размер	Paarungsmaß	medida de acoplamiento	dimensione di connessione	passningsmått	–	–
43	mating surface; fit surface	surface d'ajustement	сопрягаемая поверхность	Paßfläche	superficie de un ajuste	superficie di accoppiamento	passningsyta	–	–
44	maximum clearance	jeu maximal	наибольший зазор	Höchstspiel; Größtspiel	juego máximo	giuoco massimo	maxspel	最大すきま	4.8.2

Reference No.	English	French	Russian	German	Spanish	Italian	Swedish	Japanese	Reference clause
45	maximum interference	serrage maximal	наибольший натяг	Höchstübermaß ; Größtübermaß	aprieto máximo	interferenza massima	maxgrepp	最大しめしろ	4.9.2
46	maximum limit of size	dimension maximale	наибольший предельный размер	Höchstmaß ; Größtmaß	medida máxima	dimensione massima	övre gränsmått	最大許容寸法	4.3.3.1
47	maximum material limit (MML)	dimension du maximum de matière (MML)	предел максимума материала (*MML*)	Maximum-Material-Maß	límite de material máximo	dimensione di massimo materiale	max. materialmått; gågräns	最大実体寸法	4.12
48	mean clearance	jeu moyen	средний зазор	mittleres Spiel ; Mittenspiel	juego medio	giuoco medio	medelspel	–	–
49	mean fit	ajustement moyen	среднее значение посадки	mittlere Passung ; Mittenpassung	ajuste medio	accoppiamento medio	medelpassning	–	–
50	mean interference	serrage moyen	средний натяг	mittleres Übermaß ; Mittenübermaß	aprieto medio	interferenza media	medelgrepp	–	–
51	mean of the limits of size ; mean size	moyenne des dimensions limites ; dimension moyenne	среднее значение предельных размеров ; средний размер	mittleres Grenzmaß ; Mittenmaß	media de medidas limites ; medida media	media delle dimensioni limiti ; dimensione media	gränsmåttens mittvärde	–	–
52	minimum clearance	jeu minimal	наименьший зазор	Mindestspiel ; Kleinstspiel	juego mínimo	giuoco minimo	minspel	最小すきま	4.8.1
53	minimum interference	serrage minimal	наименьший натяг	Mindestübermaß ; Kleinstübermaß	aprieto mínimo	interferenza minima	mingrepp	最小しめしろ	4.9.1
54	minimum limit of size	dimension minimale	наименьший предельный размер	Mindestmaß ; Kleinstmaß	medida mínima	dimensione minima	undre gränsmått	最小許容寸法	4.3.3.2
55	negative deviation	écart négatif	отрицательное отклонение	negatives Abmaß	desviación negativo	scostamento negativo	negativt avmått	負の寸法差	Figure 13
56	nominal size ; basic size	dimension nominale	номинальный размер	Nennmaß	medida nominal	dimensione nominale	nominellt mått ; basmått	基準寸法	4.3.1
57	permissible deviations [1]	écarts permissibles	допустимые отклонения	Grenzabweichungen ; zulässige Abweichungen	desviaciones admisibles	scostamenti ammessi [ammissibili]	tillåtna avvikelser		–
58	plug [= shaft]	tige [= arbre]	калибр-пробка [= вал]	Dorn [= Welle]	eje	perno [= albero]	dorn [= axel]		–
59	positive deviation	écart positif	положительное отклонение	positives Abmaß	desviación positiva	scostamento positivo	positivt avmått	正の寸法差	Figure 13

1) Equivalent to "limit deviations".

Reference No.	English	French	Russian	German	Spanish	Italian	Swedish	Japanese	Reference clause
60	range [step] of basic [nominal] sizes	palier de dimensions nominales	интервал номинальных размеров	Nennmaßbereich	grupo de medidas nominales	grupo di dimensionali nominali	basmåttsområden	基準寸法の区分	A.2
61	reference temperature	température de référence	нормальная температура	Bezugstemperatur	temperatura de referencia	temperatura di riferimento	referenstemperatur	標準温度	7
62	relative clearance (‰)	jeu relatif (‰)	относительный зазор (‰)	relatives Spiel (‰); bezogenes Spiel	juego relativo (‰)	giuoco relativo (‰)	relativt spel (‰)	–	–
63	relative interference (‰)	jeu relatif (‰)	относительный натяг (‰)	relatives Übermaß; bezogenes Übermaß (‰)	aprieto relativo (‰)	interferenza relativa (‰)	relativt grepp (‰)	–	–
64	shaft	arbre	вал	Welle	eje	albero	axel	軸	4.1
65	size; dimension	dimension; cote [1]	размер	Maß	medida; dimensión	dimensione	mått; dimension	寸法	4.3
66	size without (direct) tolerance indication	dimension sans indication (directe) de tolérances	размер без [прямого] указания допуска	Maß ohne [direkte] Toleranzangabe; Freimaß	medida sin indicación directa de tolerancias	dimensione senza indicazione [diretta] di tolleranza	icke direkt toleranssatta mått	–	–
67	sleeve [= hole]	douille [= alésage]	калибр-кольцо [= отверстие]	Hülse [= Bohrung]	casquillo [= agujero]	bossolo [= foro]	hylsa [= hål]	–	–
68	standard tolerance factor (i, I)	facteur de tolérance (i, I)	единица допуска (i, I)	Toleranzfaktor (i, I); Toleranzeinheit	unidad de tolerancia (i, I)	unità di tolleranza (i, I)	toleransenhet (i, I)	公差単位	4.7.5
69	statistical tolerance	tolérance statistique	статистический допуск	statistische Toleranz	tolerancia estadística	tolleranza statistica	statistisk tolerans	–	–
70	step [rahge] of nominal sizes	palier de dimensions nominales	интервал номинальных размеров	Nennmaßbereich	grupo de medidas nominales	gruppo di dimensioni nominali	steg (områden) av nominella mått	基準寸法の区分	A.2
71	symmetrical deviations	écarts symétriques	симметричные отклонения	symmetrische Abmaße	desviaciones simétricas	scostamenti simmetrici	symmetriska avmått	–	–
72	temporary size	dimension auxiliaire	вспомогательный размер	Hilfsmaß	medida auxiliar	dimensione ausiliaria	hjälpmått	–	–
73	theoretically exact reference size	dimension de référence théoriquement exacte	теоретический размер	theoretisch genaues Bezugsmaß	medida absoluta de referencia	dimensione teoricamente esatto di riferimento	teoretiskt exakt referensmått	–	–
74	tightest extreme of fit	limite d'ajustement le plus étroit	наиболее плотная посадка	Mindestpassung; engste Grenzpassung	ajuste límite con mínimo juego	accoppiamento limite il più stretto	min. gränspassning	–	–

1) In French a "dimension" is named "cote" when it is on a drawing.

Reference No.	English	French	Russian	German	Spanish	Italian	Swedish	Japanese	Reference clause
75	tolerance	tolérance	допуск	Toleranz	tolerancia	tolleranza	toleransvidd; tolerans	寸法公差	4.7
76	tolerance class	classe de tolérance; série de tolérances d'une zone	поле допуска	Toleranzklasse; Toleranzfeldreihe	clase de tolerancias; serie de tolerancias de un campo	classe di tolleranze	tolerans; toleransklass	公差域クラス	4.7.4
77	tolerance grade; grade of tolerance	degré de tolérance; qualité de tolérance (ancien)	степень допуска	Toleranzgrad; Toleranzqualität (ehemals)	grado de tolerancia	grado di tolleranza	toleransgrad	公差等級	4.7.2
78	tolerance of fit; variation of fit	tolérance d'ajustement; variation de l'ajustement	допуск посадки	Paßtoleranz	tolerancia de ajuste; variación de ajuste	tolleranza di accoppiamento	passningens toleransvidd; passningsvariation	はめあいの変動量	4.10.4
79	tolerance of form	tolérance de forme	допуск формы	Formtoleranz	tolerancia de forma	tolleranza di forma	formtolerans	形状公差	5.3.2
80	tolerance of position	tolérance de position	допуск расположения	Lagetoleranz	tolerancia de posición	tolleranza di posizione	lägetolerans	–	–
81	tolerance position	position de la tolérance	расположение допусков	Toleranzlage	posición de tolerancia	posizione di tolleranza	toleransläge	公差域の位置	4.7.3
82	tolerance series	série de tolérances	ряд допусков	Toleranzreihe	serie de tolerancias	serie [gamma] di tolleranza	serie av toleransvidder	–	–
83	tolerance symbol	symbole de tolérances	условное обозначение допусков	Toleranzsymbol; Toleranzkurzzeichen	símbolo de tolerancias	símbolo di tolleranza	toleranssymbol	寸法公差記号	5.2.2
84	tolerance system	système de tolérances	система допусков	Toleranzsystem	sistema de tolerancias	sistema di tolleranze	toleranssystem	公差方式	1 and 2
85	tolerance zone	zone de tolérance	поле допуска	Toleranzfeld	zona de tolerancia	zona di tolleranza	toleransområde; toleranszon	公差域	4.7.3
86	toleranced size	dimension tolérancée	размер с допуском	toleriertes Maß	medida con tolerancia	dimensione con tolleranza	toleransbestämt mått	–	–
87	transition fit	ajustement incertain	переходная посадка	Übergangspassung	ajuste indeterminado	accoppiamento incerto	mellanpassning	中間ばめ	4.10.3
88	upper deviation	écart supérieur	верхнее отклонение	oberes Abmaß	desviación superior	scostamento superiore	övre gränsavmått	上の寸法許容差	4.6.1.1
89	variation of fit; fit tolerance	tolérance d'ajustement	допуск посадки	Paßtoleranz	tolerancia de ajuste	tolleranza [variazione] di accoppiamento	passningsvariation; passnings toleransens vidd	はめあいの変動量	4.10.4
90	zero line	ligne zéro	нулевая линия	Nullinie	línea cero; línea de referencia	linea dello zero	nollinje	基準線	4.5

(*Continued from second cover*)

In the adopted standard certain terminology and conventions are not identical with those used in the Indian Standard, attention is especially drawn to the following:

a) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use point (.) as the decimal marker.

b) Wherever the words 'International Standards' appear, referring to this standard, they shall be read as 'Indian Standard'.

In the adopted standard reference appears to certain international standards for which Indian Standard also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 286-2 : 1988	IS 919 (Part 2) : 1993 ISO system of limits and fits : Part 2 Tables of standard tolerance grades and limit deviations for holes and shafts (*first revision*)	Identical
ISO 8015 : 1985	IS 12160 : 1987 Technical drawings — Fundamental tolerancing principles	Identical

The concerned technical committee has reviewed the provision of ISO 1 and ISO/R 1938 referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard.

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