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ISO system of limits and fits— Part 1 : Bases of tolerances, deviations and fits

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B 0401-1 : 1998 (ISO 286-1 : 1988)

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS B 0401 : 1986** is replaced with **JIS B 0401-1 : 1998**.

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ISO system of limits and fits — Part 1 : Bases of tolerances, deviations and fits

Introduction This Japanese Industrial Standard prepared based on the first edition issued in 1988 of **ISO 286-1** *ISO systems of limits and fits — Part 1: Bases of tolerances, deviations and fits* without modifying its technical contents.

The "Informative reference" underlined with dots in this Standard is the item not included in the original International Standard.

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 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 this Standard and other standards on tolerances.

Informative reference: Annex 1 gives lists of fits used frequently.

1 Scope This part of **JIS B 0401** gives the bases of the 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 Annex A, **A.1**).

This part of **JIS B 0401** also gives terms and definitions together with associated symbols.

2 Field of application The 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 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.

Remarks: 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 **JIS B 0401**, a simple geometric form consists of a cylindrical surface area or two parallel planes.

3 Normative references

Remarks: See also clause 10.

The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards indicated below shall be applied.

JIS B 0024 *Technical drawings — Fundamental tolerancing principle*

Remarks: **ISO 8015**, *Technical drawings — Fundamental tolerancing principle* is identical to the said standard.

JIS B 0401-2 *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

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

ISO 1 *Standard reference temperature for industrial length measurements*

ISO/R 1938 *ISO systems of limits and fits — Inspection of plain workpieces*⁽¹⁾

4 Terms and definitions For the purposes of this 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 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).

Note ⁽¹⁾ At present under revision.

For the purposes of the 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 The size from which the limits of size are derived by the application of the upper and lower deviations (see Fig. 1).

Remarks: 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 Fig. 1).

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

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

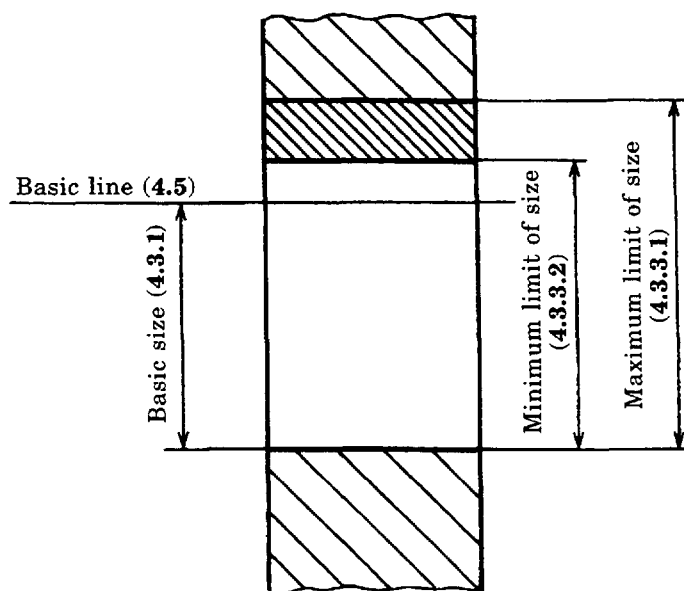


Fig. 1 Basic size, and maximum and minimum limits of size

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

Informative reference: $[\text{deviation}] = [\text{size}] - [\text{basic size}]$

Remarks: Symbols for shaft deviations are lower case letters (*es*, *ei*) and symbols for hole deviations are upper case letters (*ES*, *EI*) (see Fig. 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 Fig. 2).

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

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

Remarks: 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.

Remarks: The tolerance is an absolute value without sign.

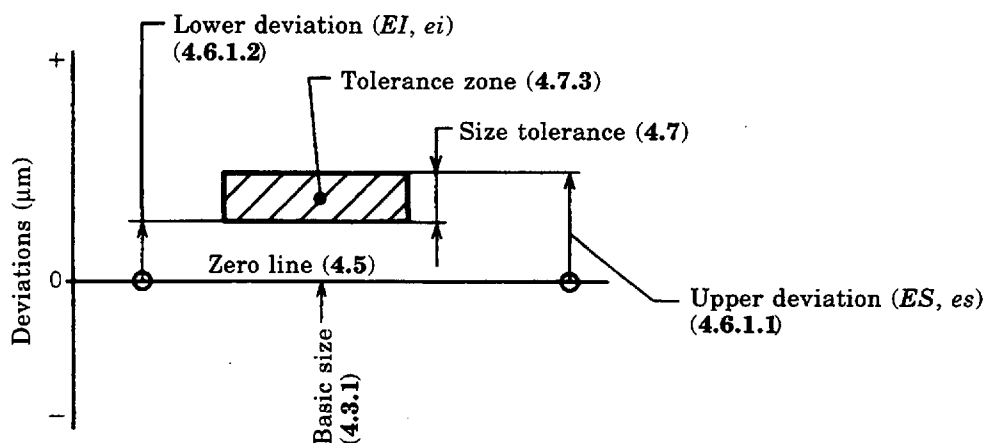


Fig. 2 Conventional representation of a tolerance zone

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

Remarks: The letters of the symbol *IT* stand for "International Tolerance" grade.

4.7.2 standard tolerance grades For the purposes of the 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 Fig. 2).

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

Informative reference: A tolerance class may be also called a tolerance symbol.

4.7.5 standard tolerance factor (i , I) For the purposes of the 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.

- Remarks
- 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 Fig. 3).

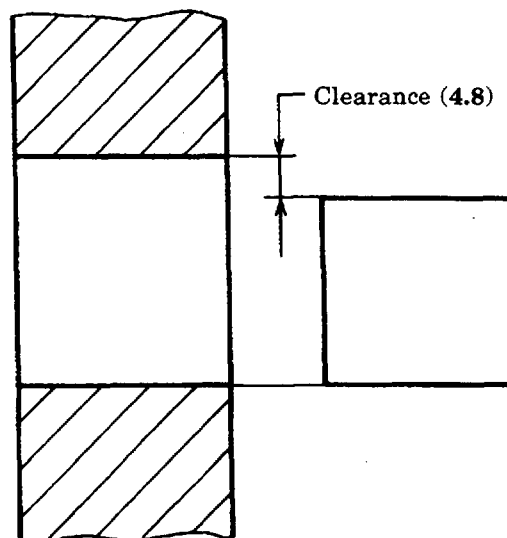


Fig. 3 Clearance

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 Fig. 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 Figs. 4 and 5).

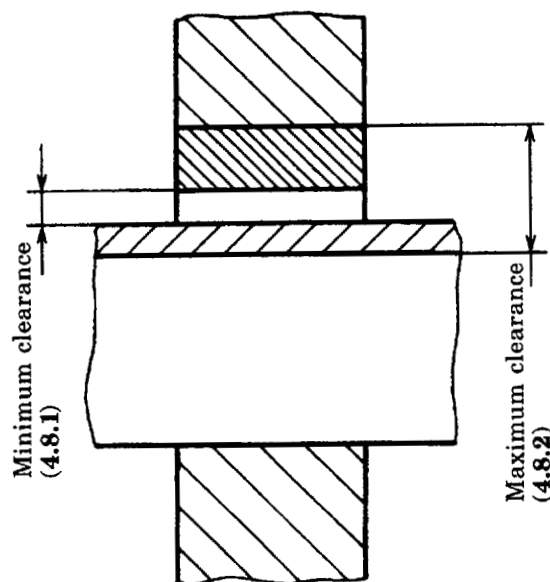


Fig. 4 Clearance fit

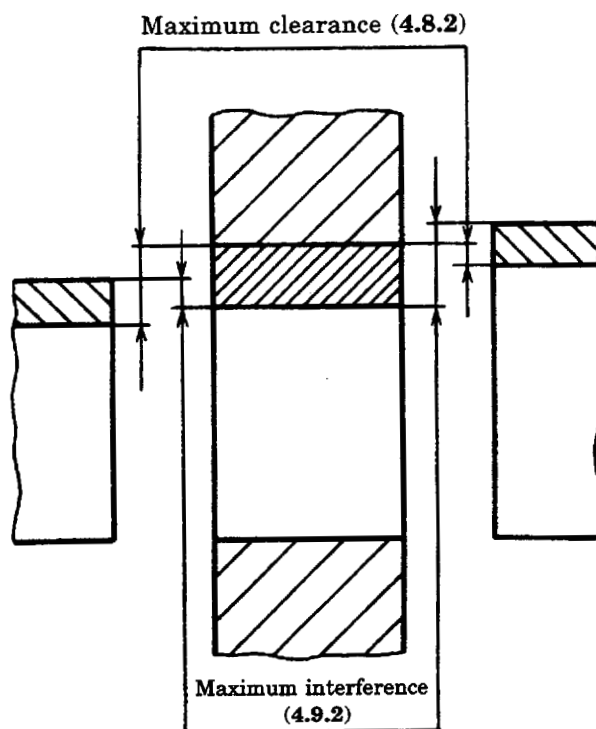


Fig. 5 Transition fit

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 Fig. 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 Fig. 7).

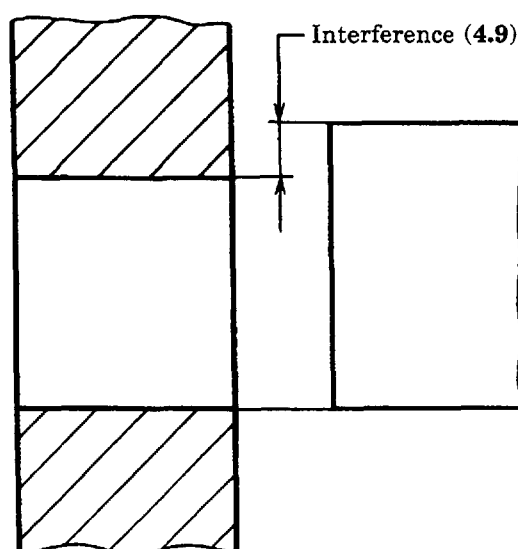


Fig. 6 Interference

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 Figs. 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.

Remarks: The two mating parts of a fit have a common basic size.

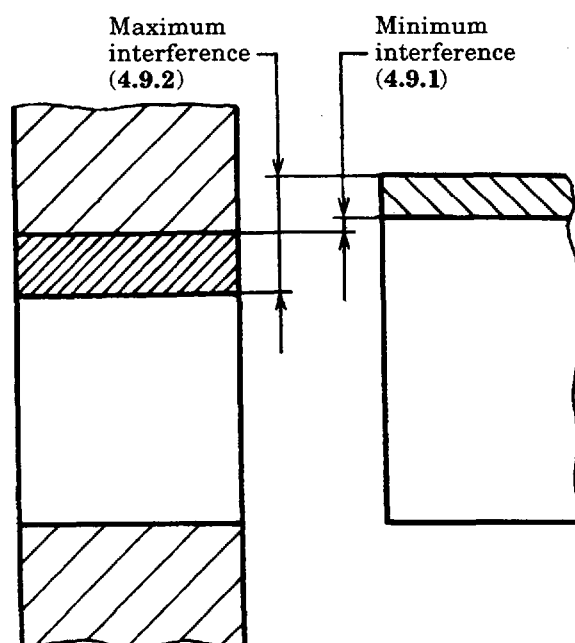


Fig. 7 Interference fit

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 Fig. 8).

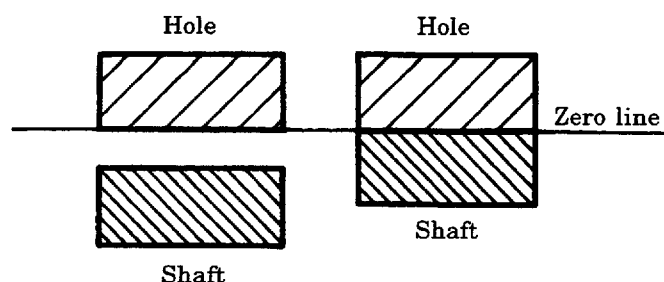


Fig. 8 Schematic representation of clearance fits

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 Fig. 9).

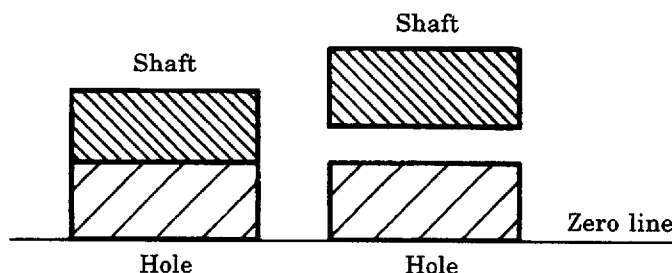


Fig. 9 Schematic representation of interference fits

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 Fig. 10).

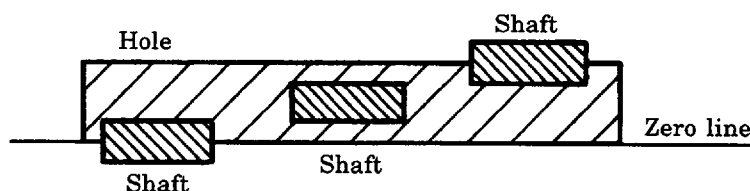


Fig. 10 Schematic representation of transition fits

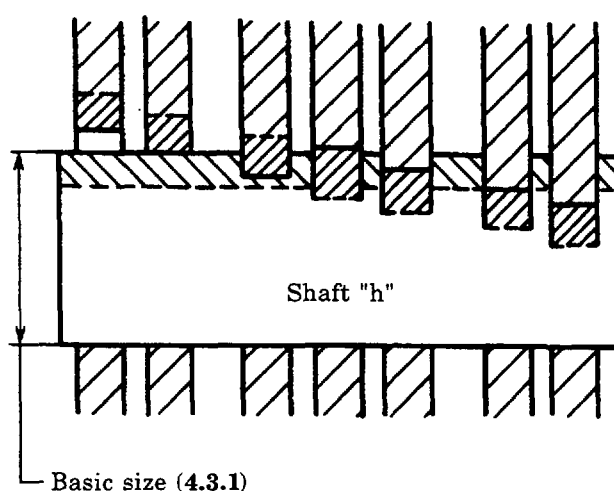
4.10.4 variation of a fit The arithmetic sum of the tolerances of the two features comprising the fit.

Remarks: 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 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 Fig. 11).

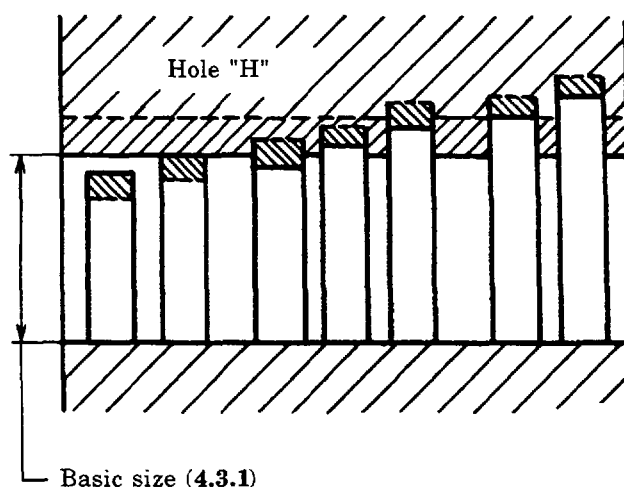


- Remarks
- 1 The horizontal continuous lines represent the fundamental deviations for holes or shafts.
 - 2 The dashed lines represent the other limits and show the possibility of different combinations between holes and shafts, related to their grade of tolerance (e.g. G7/h4, H6/h4, M5/h4).

Fig. 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 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 Fig. 12).



- Remarks
- 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).

Fig. 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).

Remarks: 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).

Remarks: 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.

Remarks: The 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

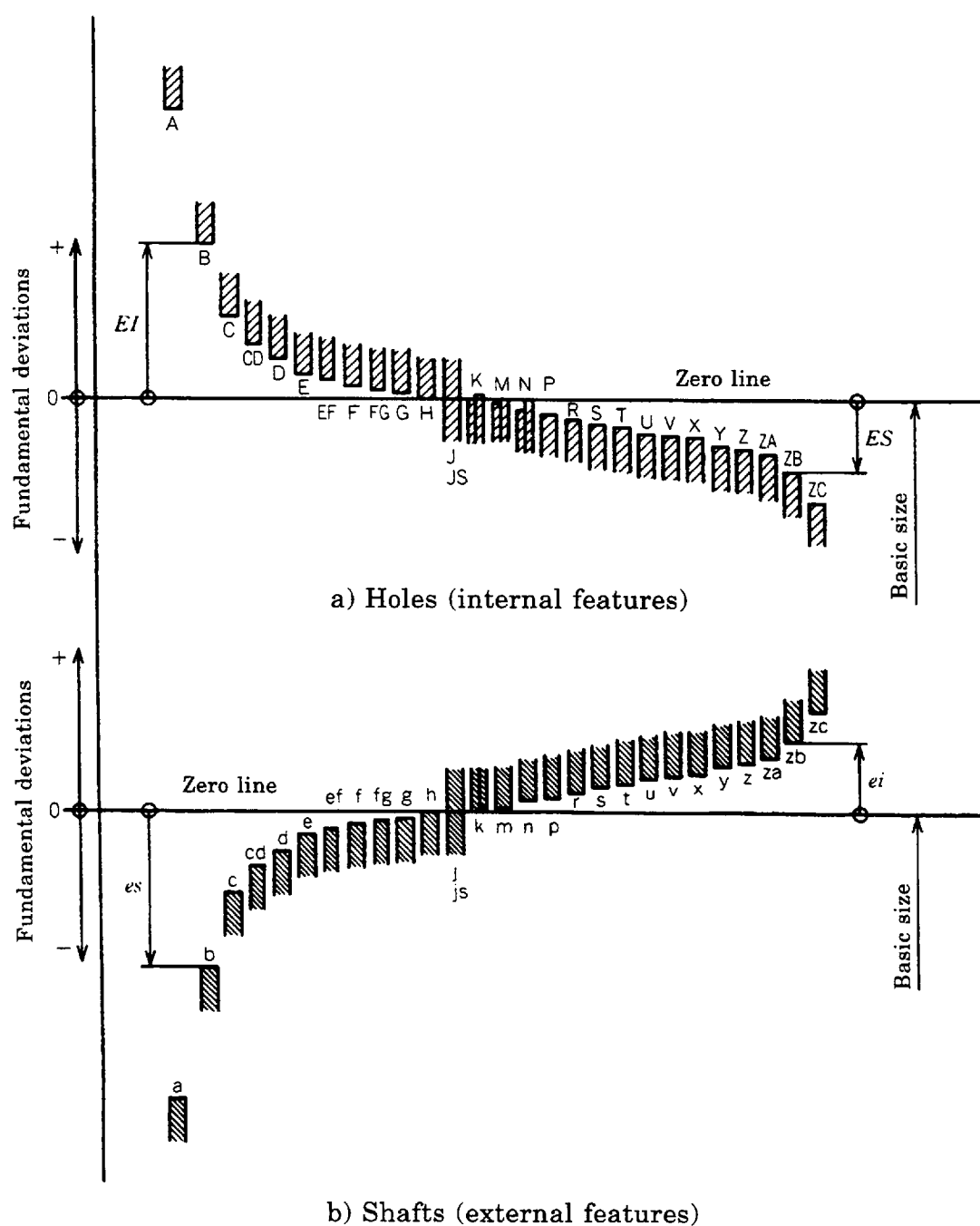
5.1.2.1 Position of tolerance zone The position of the tolerance zone with respect to the zero line, which is a function of the basic size, is designated by (an) upper case letter(s) for holes (A...ZC) or (a) lower case letter(s) for shafts (a...zc) (see Figs. 13 and 14).

Remarks: 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.



- Remarks
- 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 Fig. 14.

Fig. 13 Schematic representation of the positions of fundamental deviations

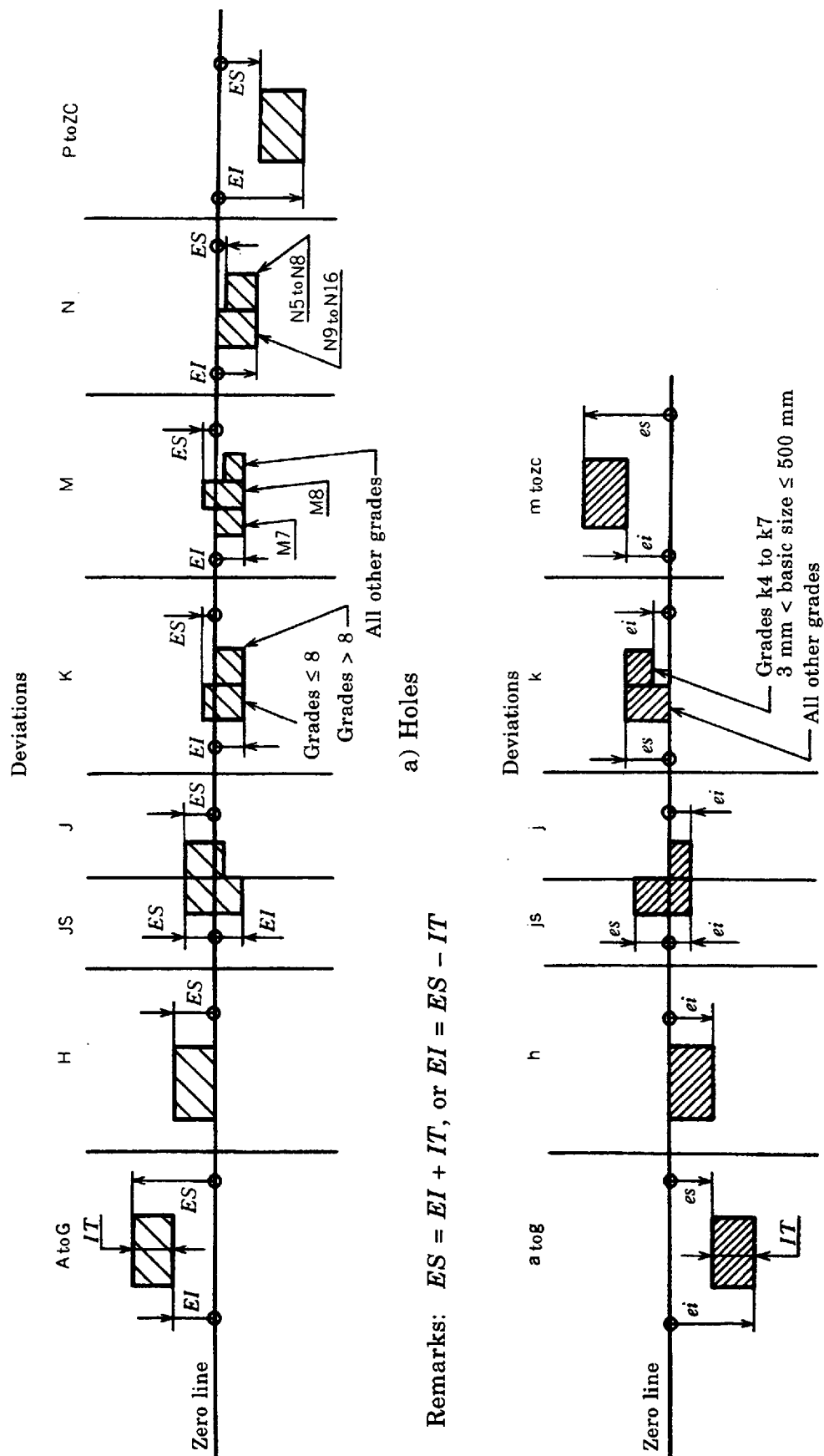


Fig. 14 Deviations for shafts and holes