
British Standard

ISO limits and fits

Part 5. Specification for system of cone tolerances for conical work pieces from $C = 1 : 3$ to $1 : 500$ and lengths from 6 mm to 630 mm

[ISO title: System of cone tolerances for conical work pieces from $C = 1:3$ to $1:500$ and lengths from 6 to 630 mm]

Système ISO de tolérances et d'ajustements

Partie 5. Systèmes de tolérances de conicité pour pièces coniques de conicité $C = 1:3$ à $1:500$ et de longueur 6 à 630 mm — Spécifications

ISO Toleranzen und Passungen

Teil 5. Kegeltoleranzen für kegelige Werkstücke von Kegel $1:3$ bis $1:500$ und Längen von 6 mm bis 630 mm

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National foreword

This British Standard has been prepared under the direction of the Machine, Engineers and Hand Tools Standards Committee. It is identical with ISO 1947-1973 'System of cone tolerances for conical workpieces from $C = 1:3$ to $1:500$ and lengths from 6 to 630 mm', which was prepared by Technical Committee ISO/TC 3 of the International Organization for Standardization (ISO), and in the development of which the UK played an active part.

Terminology and conventions. The text of the international standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

The comma has been used as a decimal marker. In British Standards it is current practice to use a full point on the base-line as the decimal marker.

Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'British Standard'.

Cross-references

NOTE. The international standards referred to in clause 1 prefixed by ISO/R have all been revised and published as international standards.

International standard	Corresponding British Standard
ISO 492-1986	BS 6107 Rolling bearings : tolerances Part 2 : 1987 Specification for tolerances of radial bearings (Identical)

The Technical Committee has reviewed the provisions of ISO 3040-1974, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. Footnote 3 to clause 1 is no longer applicable.

A related British Standard to ISO 1101-1983 is BS 308 : Part 3 : 1972 'Geometrical tolerancing'.

Reference is made in the text to a standard for the system of cone fits (see footnote 2 to clause 1). This standard has now been published as ISO 5166-1982 which is identical with BS 4500 'ISO limits and fits' Part 4 : 1985 'Specification for system of cone (taper) fits for cones from $C = 1:3$ to $1:500$, lengths from 6 mm to 630 mm and diameters up to 500 mm'.

Textual error. When adopting the text of the international standard, the textual error given below was discovered. It has been reported to ISO in a proposal to amend the text of the international standard.

In the annex, for grade IT 14, cone diameters over 400 mm to 500 mm, '15 000' should be read as '15 500'.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

British Standard

ISO limits and fits

Part 4. Specification for system of cone tolerances for conical workpieces
from $C = 1:3$ to $1:500$ and lengths from 6 mm to 630 mm

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a cone tolerance system which applies to rigid conical workpieces for which the length of the generator can be considered as practically equal to the basic cone length; this applies in the case of cones having a rate of taper $C = 1:3$ to $1:500$.¹⁾

The appropriate tolerances of this International Standard can also be used for prismatic workpieces, for example wedges.

For the system of cone fits, see ISO ²⁾

For dimensioning and tolerancing cones on drawings, see ISO 3040, *Technical drawings — Dimensions and tolerancing cones*.³⁾

For general information on tolerances of form and of position, see ISO/R 1101, *Tolerances of form and of position — Part 1 : Generalities, symbols, indications on drawings*.

For cone tolerances for rolling bearings, see ISO/R 492, *Rolling bearings — Radial bearings — Tolerances*.

The verification of cones will be the subject of a future document.

2 BASIS OF THE SYSTEM

2.1 Types of cone tolerance

The following four types of tolerance provide the basis of the cone tolerance system :

- a) cone diameter tolerance T_D , valid for all cone diameters within the cone length L ;
- b) cone angle tolerance AT , given in angular or linear dimensions (AT_α or AT_D);
- c) cone form tolerance T_F (tolerances for the straightness of the generator and for the roundness of the section);
- d) cone section diameter tolerance T_{DS} , given for the cone diameter in a defined section. It is valid for the cone diameter of this section only.

2.2 Cone diameter tolerance, cone angle tolerance and cone form tolerance

Normal cases will be handled by application of the cone diameter tolerance T_D only. It includes the two tolerances of the types b) and c). This means that the deviations of these two types may, in principle, utilize the whole tolerance space given by the cone diameter tolerance T_D .

In case of stronger requirements, the cone angle tolerance and the cone form tolerance may be reduced within the cone diameter tolerance T_D by means of supplementary instructions. In this case likewise, no point on the conical surface is permitted to lie outside the limit cones given by T_D .

In practice, all types of tolerance generally exist at the same time and, as far as normal cases are concerned, each tolerance may occupy a part of the cone diameter tolerance T_D only in such a way that no point on the conical surface lies outside the tolerance space. In other words, no point on the conical surface is permitted to lie outside the limit cones.

2.3 Cone section diameter tolerance

If for functional reasons the cone diameter tolerance is required in a defined section, then the cone diameter tolerance T_{DS} (tolerance type d)) must be indicated. In this case, it is also necessary to indicate the cone angle tolerance.

If general tolerances for the cone angle are specified, for example in an international document, and if it is referred to this tolerance, then it is not necessary to indicate special cone angle tolerances.

3 DEFINITIONS

3.1 DEFINITIONS RELATING TO CONES

3.1.1 cone : A conical surface or a conical workpiece (see Figure 1), defined by its geometrical dimensions.

In the absence of any indication concerning the geometrical form, "cone" is understood to mean a straight circular cone or truncated cone.

1) For cones of $1:3$ up to $1:500$, the length of the generator and the cone length may be regarded as equal, since these lengths give differences in cone angle tolerances of less than 2 %.

2) In preparation.

3) At present at the stage of draft.

3.1.2 conical surface : A surface of revolution which is formed by rotating a straight line (generator) around an axis with the straight line intersecting this axis at the apex (see Figure 1).

The parts of this infinite conical surface are also known as conical surfaces or cones. Similarly, "cone" is also the abbreviated designation of a truncated cone.

3.1.3 conical workpiece : A workpiece or portion of a workpiece the main part of which is a conical surface (see Figures 2 and 3).

3.1.4 external cone : A cone which limits the outside form of a conical feature of a workpiece (see Figures 2 and 6).

3.1.5 internal cone : A cone which limits the inside form of a conical feature of a workpiece (see Figures 3 and 6).

3.1.6 basic cone : The geometrically ideal conical surface which is given by its geometrical dimensions. These are either

- a) a basic cone diameter, the basic cone length and the basic rate of taper or the basic cone angle, or
- b) two basic cone diameters and the basic cone length (see Figure 4).

3.1.7 actual cone : That cone the conical surface of which has been found by measurement (see Figure 5).

3.1.8 limit cones : The geometrically ideal coaxial surfaces, having the same basic cone angle, which result from the basic cone and the cone diameter tolerances. The difference between the largest and the smallest cone diameters is the same in all sections normal to the cone axis (see Figure 8).

The surfaces of the limit cones may be made to coincide by axial displacement.

3.1.9 generator : The line of intersection of the conical surface with a section in the axial plane (see Figures 1 and 6).

3.2 DEFINITIONS RELATING TO SIZES ON CONES

3.2.1 cone diameter : The distance between two parallel lines tangent to the intersection of the circular conical surface with a plane normal to the cone axis.

3.2.2 basic cone diameters are as follows : (see Figure 4)

- a) the largest cone diameter D , or
- b) the smallest cone diameter d , or
- c) the cone diameter d_x at a place determined by its position in the axial direction.

3.2.3 actual cone diameter d_a : The distance between two parallel tangents to the intersection line of the surface of the actual cone with a defined plane normal to the cone axis (see Figure 5).

3.2.4 limit cone diameters : The diameters of the limit cones in each section in a plane normal to the axis (see Figure 8).

3.2.5 basic cone length L : The distance in the axial direction between two limiting ends of a cone (see Figures 4 and 6).

3.2.6 basic cone angle α : The angle formed by the two generators of the basic cone in a section in the axial plane (see Figure 7).

3.2.7 limit cone angles : The largest and the smallest cone angles resulting from the basic cone angle α and the d position and magnitude of the cone angle tolerance (see Figure 10).

3.2.8 cone generating angle $\alpha/2$: The angle contained between a generator and the cone axis (see Figure 7).

The generating angle is equal to half the basic cone angle α .

3.2.9 rate of taper C : The ratio of the difference between the cone diameters D and d to the cone length L .

$$C = \frac{D - d}{L} = 2 \tan \frac{\alpha}{2}$$

The rate of taper is often indicated by the expressions $1 : x$ or $1/x$ and "Cone $1 : x$ " for short. For example, $C = 1 : 20$ means that a diameter difference $D - d$ of 1 mm occurs an axial distance L of 20 mm between the cone diameters D and d .

3.3 DEFINITIONS RELATING TO CONE TOLERANCES

3.3.1 cone tolerance system : A system containing the cone diameter tolerances, the cone angle tolerances and the tolerances on the cone form of the generator and the circumferential line of the section normal to the cone axis.

3.3.2 cone diameter tolerance T_D : The difference between the largest and smallest permissible cone diameters in any section, i.e. between the limit cones (see Figure 8).

3.3.3 cone angle tolerance AT^1 : The difference between the largest and smallest permissible cone angles (see Figures 10 and 15).

3.3.4 cone form tolerances T_F :

3.3.4.1 tolerance on the straightness of the generator : The distance between two parallel, straight lines between which the actual generator must lie (see Figure 8).

1) AT = angle tolerance.

The actual value for the error on straightness is taken as the distance between two parallel straight lines touching the actual generator, and so placed that the distance between them is a minimum.

3.3.4.2 tolerance on the roundness of the section : The distance between two coplanar concentric circles in a section normal to the axis between which the actual cone section must be situated (see Figure 9).

The actual value for the error on roundness is taken as the distance between two coplanar concentric circles which touch the actual line of any section normal to the axis.

3.3.5 cone section diameter tolerance T_{DS} : The difference between the largest and smallest permissible cone diameters in a *defined* section (see Figure 17).

3.4 DEFINITIONS RELATING TO ACTUAL CONE ANGLES

3.4.1 actual cone angle : In any axial plane section, the angle between the two pairs of parallel straight lines that enclose the form errors of the two generators in such a way that the maximum distance between them is the least possible value (see Figure 11).

For a given cone, there is not only one actual cone angle; for cones having deviations of roundness, the actual cone angle will be different in different axial planes (see α_1 and α_2 in Figure 11).

3.4.2 average actual cone angle : The arithmetical average value of the actual cone angle measured in accordance with 3.4.1 in several equally distributed axial plane sections.

Amongst the axial planes chosen, one at least shall cover the greatest deviation of roundness from the circle line of the cone diameter.

3.5 DEFINITION RELATING TO CONE TOLERANCE SPACE

3.5.1 cone tolerance space : For the conical surface, the space between the two limit cones.

Cone tolerance space includes all the tolerances referred to in 3.3. It may be represented by tolerance zones in two plane sections (see Figures 8 and 9).

3.6 DEFINITIONS RELATING TO CONE TOLERANCE ZONES

3.6.1 cone diameter tolerance zone : In a graphic representation, that zone, lying in the plane section of the cone axis, which is limited by the limit cones.

The total tolerances zone is represented in Figures 8 and 9 by the hatched portions which also indicate the cone tolerance space. It includes the tolerances for the cone diameter, the cone angle, the roundness and the straightness which can occupy the whole cone tolerance zone. In general, each of these particular deviations occupies a part of the cone diameter tolerance zone only.

3.6.2 tolerance zone for the cone angle : A fan-shaped zone within the limit cone angles.

The inclination of the limit cones can be indicated by plus, minus or plus/minus for the cone angle tolerances (see Figure 12). For the indication of plus/minus, the values can be different.

3.6.3 tolerance zone for the straightness of the generator : In a graphic representation, that zone (band), situated in any axial plane section and disposed on each side of the cone axis, which is determined by the form tolerance of the generators (see Figure 8).

As this zone is smaller than that referred to in 3.6.1, it only applies if the tolerance on the straightness of the generator is reduced with respect to the cone diameter tolerance zone. The actual generator has to be situated anywhere within a tolerance zone given by the tolerance for the straightness.

3.6.4 tolerance zone for the roundness of the section : In a graphic representation, the zone lying in a section normal to the cone axis and formed by concentric circles (see Figure 9).

As this zone is narrower than that referred to in 3.6.1, it only applies if the tolerance for the roundness of the section is reduced with respect to the cone diameter tolerance zone. The contour has to be situated anywhere within a tolerance zone given by the tolerance for the roundness of the section.

3.6.5 cone section diameter tolerance zone : The tolerance zone for the cone diameter in a defined section.

It appears in that case if the cone diameter tolerance is indicated for a fixed diameter only.

4 CONE DIAMETER TOLERANCE T_D

In general, the choice of the cone diameter tolerance T_D is based on the large cone diameter D . It is selected from the ISO standard IT tolerances and applies over the whole of the cone length L .

If it is not required to indicate smaller tolerances of angle and form, a cone diameter tolerance T_D , given on the drawing, applies also to the angle and form deviations. It should be borne in mind, however, that in this case all workpieces that conform to Figures 14 and 15 must be accepted.

The symbols of the ISO tolerances system shall be used to indicate the cone diameter tolerances referred to the corresponding cone diameter. If the conical surface of the conical workpiece concerned is not intended for a cone fit, the tolerance positions J_S and j_s should be chosen for preference, for example, $40 J_S 10$.