INTERNATIONAL STANDARD

ISO 3040

Fourth edition
2016-05-01

Geometrical product specifications (GPS) — Dimensioning and tolerancing — Cones

Spécification géométrique des produits (GPS) — Cotation et tolérancement — Cônes

Reference number
ISO 3040:2016(E)

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Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

This fourth edition cancels and replaces the third edition (ISO 3040:2009), which has been technically revised:

— Clause 6 on the tolerancing of cones has been revised;

— Annex A on former practice from ISO 3040:1990 has been deleted;

— a new informative Annex A with examples has been added.

Introduction

This International Standard is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO 14638), applicable to a conical feature. It influences chain links A and B of the chain of standards on size, form, orientation, location and run-out.

For more detailed information about the relationship of ISO 3040 to other standards and to the GPS matrix model, see Annex B.

The ISO/GPS matrix model given in ISO 14638 gives an overview of the ISO/GPS system of which this international standard is a part. The fundamental rules of ISO/GPS given in ISO 8015 apply to this international standard and the default decision rules given in ISO 14253-1 apply to specifications made in accordance with this international standard, unless otherwise indicated.

In this International Standard, the figures illustrate the text only and should not be considered as design examples. For this reason, the figures are simplified and are not to scale.

No indications from the previous edition (ISO 3040:2009) have been made obsolete by this edition. Therefore, there is no 'former practice'.

Geometrical product specifications (GPS) — Dimensioning and tolerancing — Cones

1 Scope

This International Standard specifies graphical indication applicable to a cone (right-angle circular cones) to define its dimensioning or to specify its tolerancing.

For the purposes of this International Standard, the term “cone” relates to right-angle circular cones only (any intersection by a plane perpendicular to the axis of the nominal cone is a circle).

NOTE 1 For simplicity, only truncated cones have been represented in this International Standard. However, this International Standard can be applied to any type of cone within its scope.

NOTE 2 This International Standard is not intended to prevent the use of other methods of dimensioning and tolerancing.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1119:2011, *Geometrical product specifications (GPS) — Series of conical tapers and taper angles*

ISO 81714-1, *Design of graphical symbols for use in the technical documentation of products — Part 1: Basic rules*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
rate of taper
C
ratio of the difference in the diameters of two sections of a cone to the distance between them

Note 1 to entry: lt is expressed by the following formula (see also Figure 1).

$$C = \frac{D - d}{L} = 2\tan\left(\frac{\alpha}{2}\right) \quad (1)$$

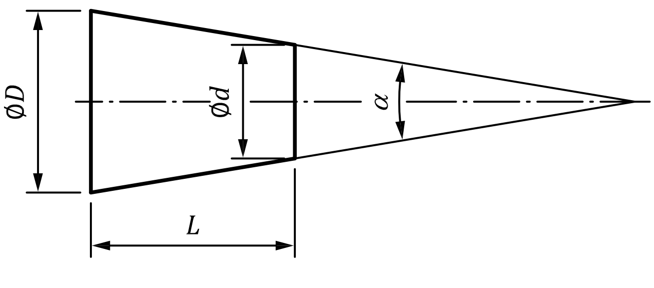


Figure 1

4 Graphical symbol for a rate of taper for a cone

A rate of taper for a cone shall be indicated using the graphical symbol illustrated in Figure 2 centred on a reference line (see Figure 7). The orientation of the graphical symbol shall coincide with that of the cone (see Figure 7 and Figure 8).

Size and line thickness of the graphical symbol are according to ISO 81714-1.

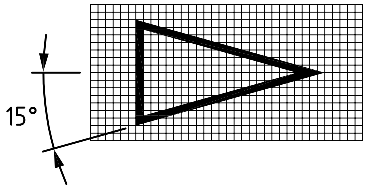


Figure 2

5 Dimensions and indication on a cone

5.1 Dimensions on a cone

Several kinds of dimensions as shown in Table 1 may be used in order to define a cone.

Table 1 — Dimensions on a cone

Type of dimensions	Letter symbol	Examples of indication	
		Preferred method	Optional method
Rate of taper value	C	1:5 1/5	0,2:1 20 %
Cone angle value	α	35°	0,6 rad
Cone diameter value			
— at the larger end	D		
— at the smaller end	d		
— at the specified cross-section	D_x		
Length value			
— Distance between two planes limiting a cone	L		
— Distance between two planes limiting a set of a cone and a cylinder	L'		
— Distance locating the cross-section where D_x is defined	L_x		

No more dimensions than necessary shall be indicated. However, additional dimensions may be given for information as auxiliary dimensions.

Some dimensions may be used to establish a tolerancing by dimensional or geometrical specification (see Clause 6). For this reason these dimensions may be defined as TEDs.

Some typical combinations of cone dimensions are shown in Figure 3, Figure 4, Figure 5 and Figure 6.

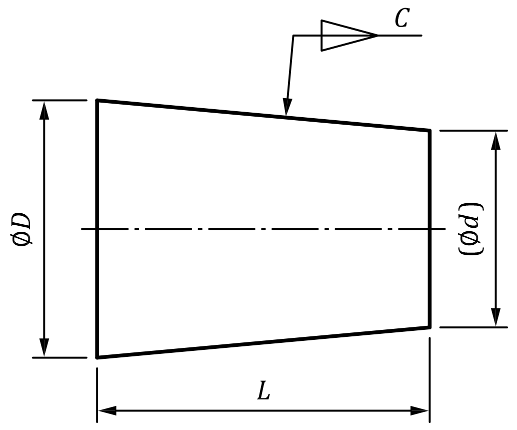


Figure 3

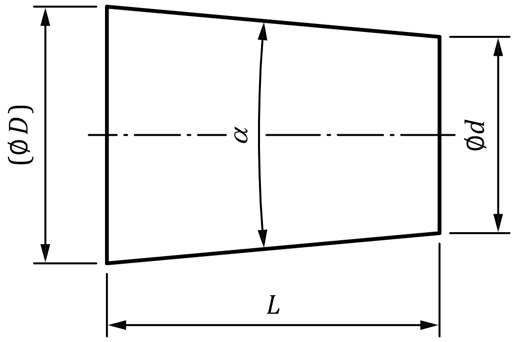


Figure 4

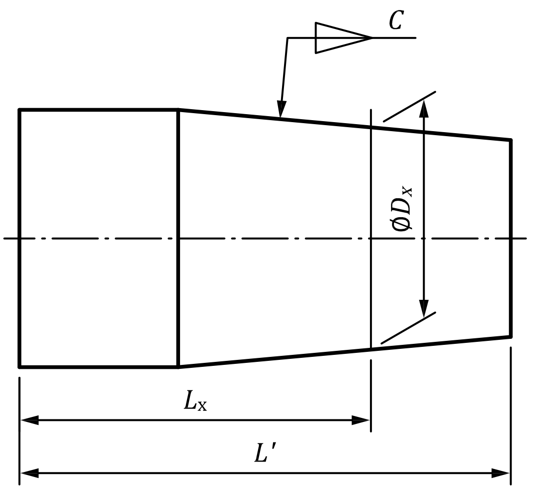


Figure 5

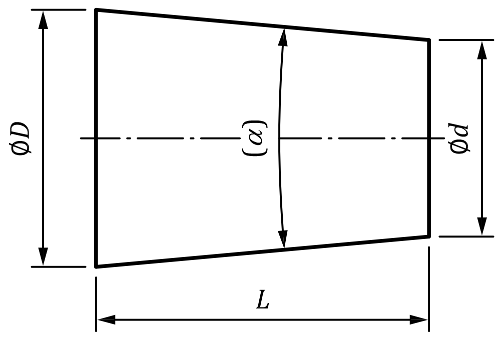


Figure 6

5.2 Indication of rate of taper value on drawings

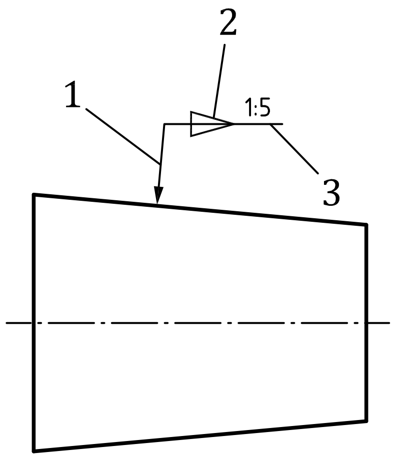
The graphical symbol with the rate of taper value of a cone shall be indicated near the feature according to the rules presented in Clause 4.

As shown in Figure 7, the reference line attached to the graphical symbol shall be:

— drawn parallel to the cone axis, and

— connected by a leader line to the outline of the cone.

When the taper belongs to a standardized series of conical taper (in particular Morse or metric taper), the rate of taper value of the cone may be replaced by the codification given by standard series according to ISO 1119 and appropriate number (see Figure 8). For example, the rate of taper value “1:20,047” may be replaced by the codification “Morse No. 1”.



Key

1 leader line

2 rate of taper graphical symbol

3 reference line

NOTE 1:5 is the rate of taper value.

Figure 7

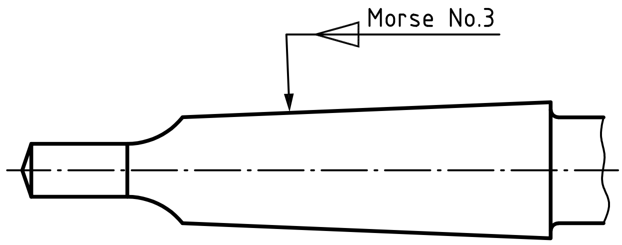


Figure 8

6 Tolerancing of a cone

A cone is intrinsically defined by its angle (see Figure 9).

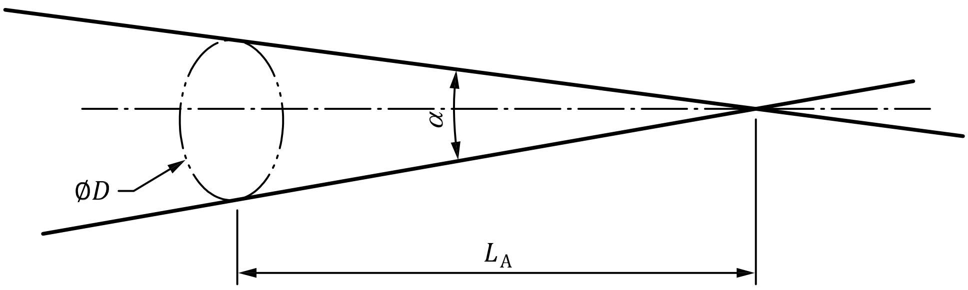
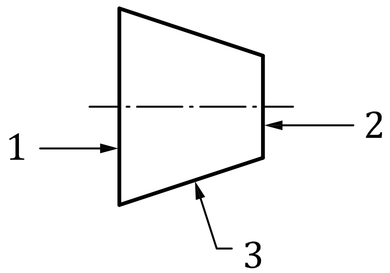


Figure 9 — Intrinsic representation of a cone

NOTE A cone is different from a frustum which is defined by three geometrical entities (one of them is a cone).

EXAMPLE A frustum defined by a cone and two end planes (not necessarily perpendicular to the axis of this cone). See Figure 10.



Key

1 Plane 1

2 Plane 2

3 cone

Figure 10 — Example

The objective of tolerancing is to define a set of one or more GPS specifications. Each GPS specification defines a particular characteristic and its permissible extent by the mean of one or two tolerances limits (see example in Figure 11).

When a gauge plane is used in a specification, the gauge plane location shall be defined by TEDs (explicit or implicit: 0 mm).

When a datum or datum system is used to locate or orientate the tolerance zone, the angular or linear dimensions constraining the tolerance zone shall be defined by TEDs (explicit or implicit:0 mm, 0°, 90 °, 180°, 270°).

When a geometrical specification is applied to a cone with the surface profile characteristic symbol without datum or datum system and the intrinsic characteristic of the cone shall be taken into account as fixed, then:

— the symbol VA shall not be indicated in the second compartment of the tolerance frame; and

— the angle of the cone shall be indicated:

  — directly with the cone angle as a TED, or

  — indirectly with the rate of taper value or by a combination of several dimensions on a cone (e.g. see Figure 6).

Each characteristic controls a set of degrees of freedom on the real workpiece.

The set of degrees of freedom, which are possible to consider individually or collectively, is:

— the angle deviation;

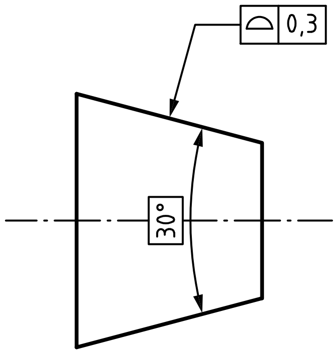
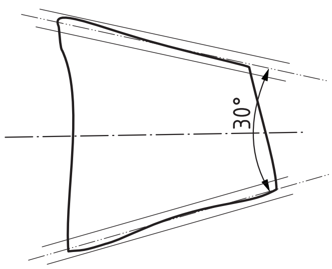
— the form deviation on a section line or the surface;

— the location deviation (X, Y, Z : in Cartesian system);

— the orientation deviation (β, γ : in Cartesian system).

The table in Figure 11 presents, for a specification, the type of deviations which are controlled. The indication of the specification is presented and its meaning is illustrated and explained. This presentation is used in Annex A.

Figure 11 and Annex A present various individual (independent) examples of possible dimensional or geometrical specifications in relation with a cone, in accordance with ISO 1101, ISO 14405-1 and ISO 14405-3. Each of these examples shall be considered independently from each other, but could be used in the same drawing on the same feature.

Indication of a form specification of the cone surface with its size considered as fixed	Meaning
	The extracted surface of the cone is required to be inside of the tolerance zone without orientation or location constraint. The tolerance zone consists of the space included between two coaxial conical surfaces with a specified theoretical angle and 0,3 mm apart. 

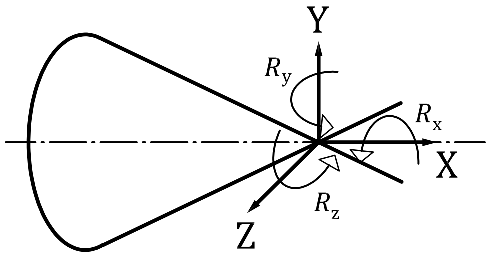
Controlled deviations								
Angle deviation	Form deviation	Location deviation			Orientation deviation			Illustration of degrees of freedom
		Tx	Ty	Tz	Rx	Ry	Rz	
Yes	Yes	No	No	No	Never	No	No	
WARNING	The orientation and location of the cone are not locked.							

Figure 11 — Example of tolerancing of a cone: specification of the surface form considering its theoretical exact angle

Annex A
(informative)

Tolerancing of a cone: Examples

A.1 General

Cones belong to the invariance class of revolute surface. Therefore, the rotation about the cone axis cannot be locked. The six degrees of freedom of a cone can be represented in a Cartesian or cylindrical coordinate system aligned with the cone axis, with its origin located at the apex of the cone.

Alternatively, the origin can be located elsewhere along the cone axis, at a nominal distance, L_A, from the apex of the cone [see Formula (A.1) and Figure 9].

$$L_A = \frac{D}{2}\left(\tan\frac{\alpha}{2}\right) \tag{A.1}$$

where

α is the cone angle;

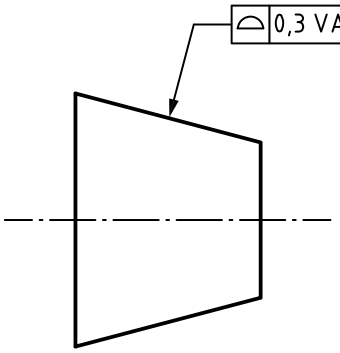
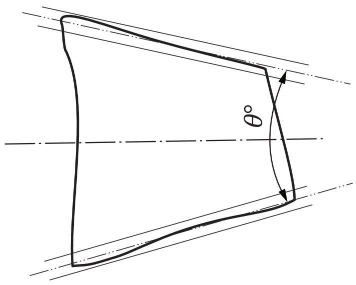
D is the nominal cross section diameter;

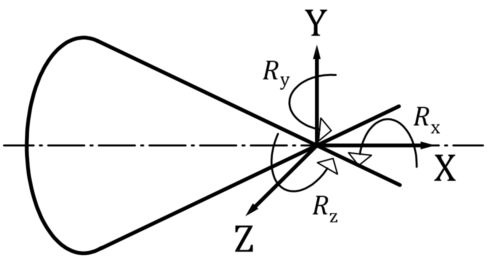
L_A is the distance between the apex of the cone and the cross section where D is defined.

A.2 Examples

Thirteen cone tolerancing examples are provided.

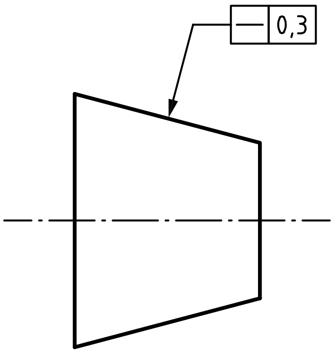
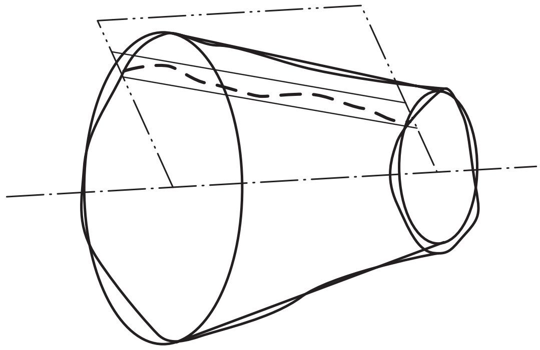
EXAMPLE 1 Cone tolerancing - surface form without considering the cone angle (illustration of the closeness to a perfect conical shape, without taking into account a predefined cone angle)

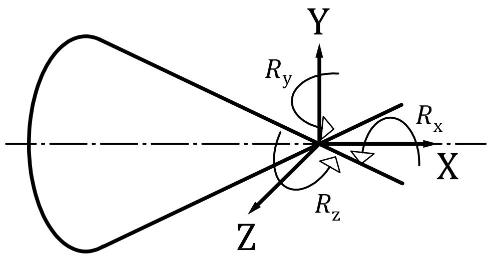
Indication of a form specification of the cone surface with its size considered as variable	**Meaning**
 	The extracted surface of the cone is required to be inside of the tolerance zone without orientation or location constraint. The tolerance zone consists of the space included between two coaxial conical surfaces with the same unspecified angle and 0,3 mm apart.  **Key** θ non predefined angle

Controlled deviations by the specification								
Angle deviation	Form deviation	Location deviation			Orientation deviation			Illustration of degrees of freedom
		Tx	Ty	Tz	Rx	Ry	Rz	
No	Yes (conical surface)	No	No	No	Never	No	No	
WARNING The orientation and location of the cone and its size are not locked.								

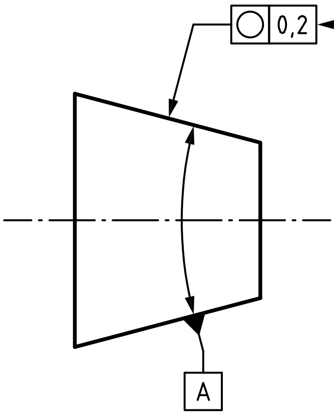
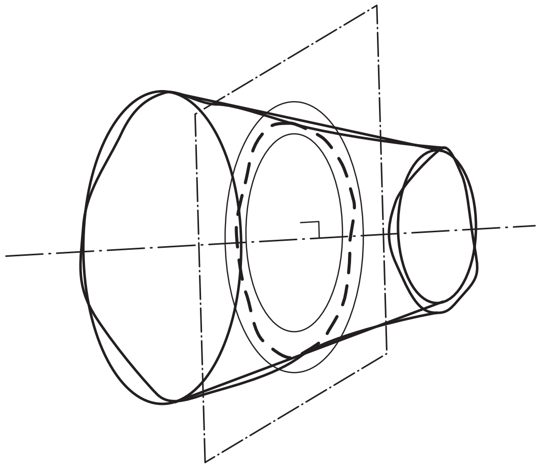
This kind of specification combines two requirements (straightness of any generatrix line or all generatrix lines and roundness of any directrix line or all directrix lines).

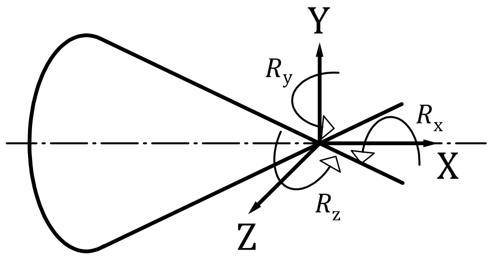
EXAMPLE 2 Cone tolerancing - form of any generatrix lines

Indication of a form specification of any generatrix of the cone (straightness)	**Meaning**
	

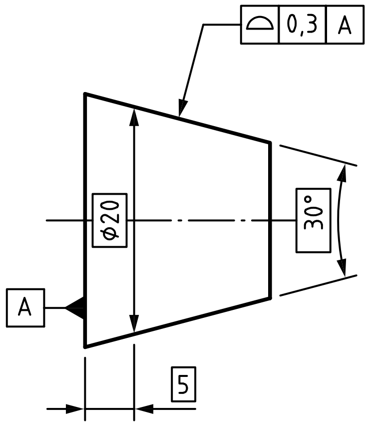
Controlled deviations by the specification								
Angle deviation	Form deviation	Location deviation			Orientation deviation			Illustration of degrees of freedom
		Tx	Ty	Tz	Rx	Ry	Rz	
No	Yes (generatrix lines)	No	No	No	Never	No	No	
WARNING The orientation and location of the cone and its size are not locked. The form of the cone is partially locked.								

EXAMPLE 3 Cone tolerancing - form of any directrix line or all directrix lines at any cross section perpendicular to the axis of the associated feature with the real surface of the cone, using the least squares criteria.

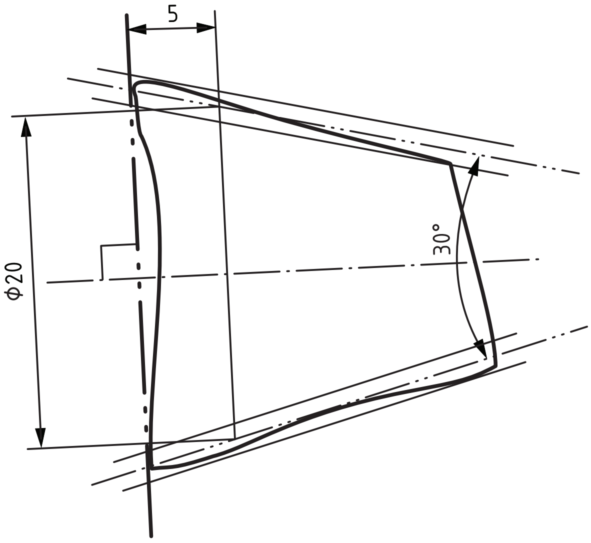
Indication of a form specification of any directrix of the cone (roundness)	Meaning
	

Controlled deviations by the specification								
Angle deviation	Form deviation	Location deviation			Orientation deviation			Illustration of degrees of freedom
		Tx	Ty	Tz	Rx	Ry	Rz	
No	Yes (directrix lines at any cross-section)	No	No	No	Never	No	No	
WARNING The orientation and location of the cone and its size are not locked. The form of the cone is partially locked.								

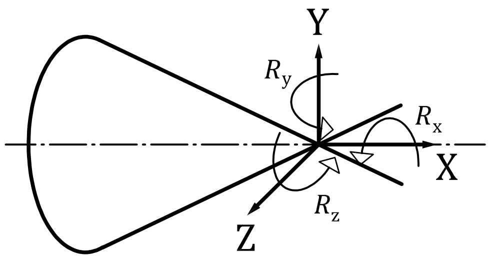
EXAMPLE 4 Cone tolerancing - surface located from an end datum. The controlled degrees of freedom (Tx, Rz, Ry) are dependent on the datum. Datum A locks the location and orientation. In this case, the orientation constraint and the location constraint are applied to lock the tolerance zone from datum A (no other restriction is required).

<table>
<tr><th>Indication of a location specification of a cone (with its size considered as fixed) from the datum A</th><th>Meaning</th></tr>
<tr><td>


</td><td>
The extracted surface of the cone is required to be inside of the tolerance zone with orientation and location constraint from the datum A: the axis of the tolerance zone is constrained perpendicular to the datum A, and the gauge plane is located at 5 mm from the datum A. The tolerance zone consists of the space included between two coaxial conical surfaces with specified theoretical angle and 0,3 mm apart.

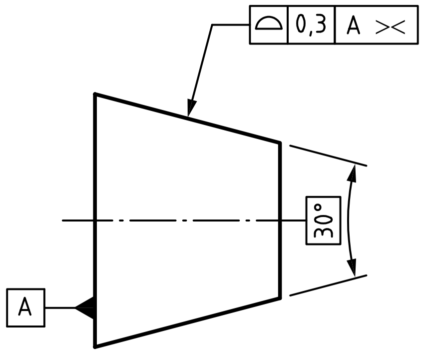
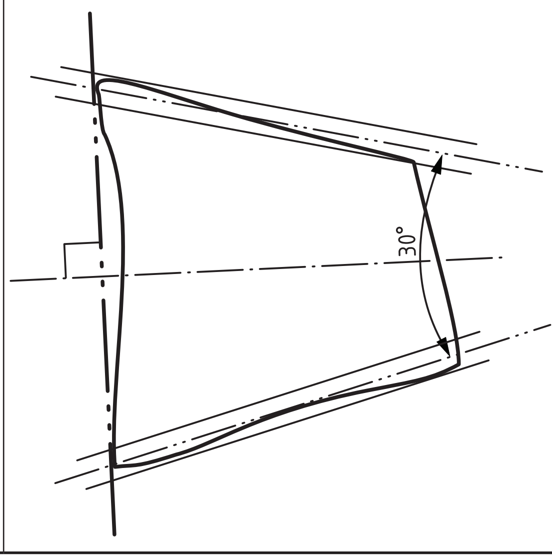


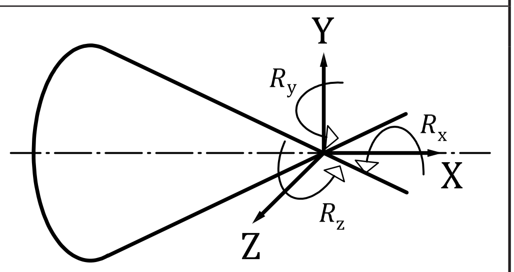
</td></tr>
</table>

<table>
<tr><th colspan="9">Controlled deviations by the specification</th></tr>
<tr><td rowspan="2">Angle deviation</td><td rowspan="2">Form deviation</td><td colspan="3">Location deviation</td><td colspan="3">Orientation deviation</td><td>Illustration of degrees of freedom</td></tr>
<tr><td>Tx</td><td>Ty</td><td>Tz</td><td>Rx</td><td>Ry</td><td>Rz</td><td rowspan="2">


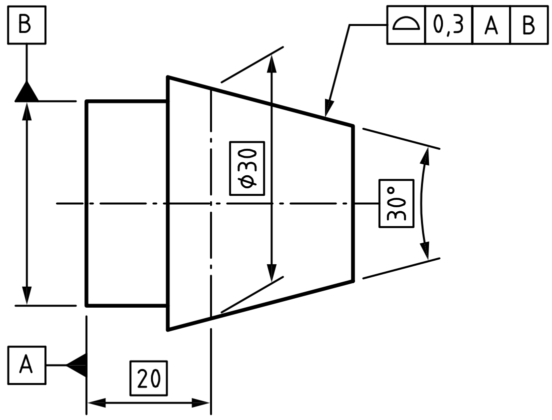
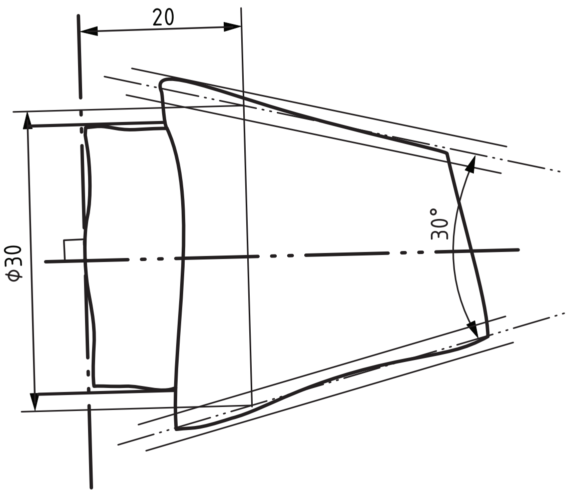
</td></tr>
<tr><td>Yes</td><td>Yes</td><td>Yes</td><td>No</td><td>No</td><td>Never</td><td>Yes</td><td>Yes</td></tr>
<tr><td colspan="9">WARNING The size, the form and the orientation of the cone are locked and the location of the cone is partially locked.</td></tr>
</table>

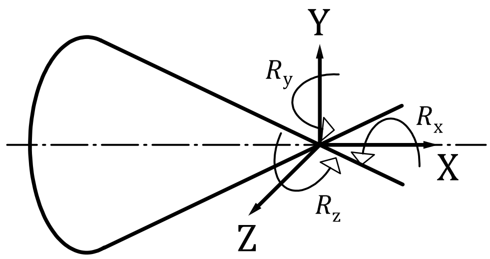
EXAMPLE 5 Cone tolerancing - surface orientated from an end datum. Datum A can lock the location and orientation, the modifier >< retains only the orientation constraint of the tolerance zone from datum A.

<table>
<tr><th>Indication of orientation specification of the cone surface (with its size considered as fixed) from the datum A</th><th>Meaning</th></tr>
<tr><td>
</td><td>The extracted surface of the cone is required to be inside of the tolerance zone with orientation constraint only from the datum A: the axis of the tolerance zone is constrained perpendicular to the datum A. The tolerance zone consists of the space included between two coaxial conical surfaces with specified theoretical angle and 0,3 mm apart.

</td></tr>
</table>

<table>
<tr><th colspan="9">Controlled deviations by the specification</th></tr>
<tr><td rowspan="2">Angle deviation</td><td rowspan="2">Form deviation</td><td colspan="3">Location deviation</td><td colspan="3">Orientation deviation</td><td>Illustration of degrees of freedom</td></tr>
<tr><td>Tx</td><td>Ty</td><td>Tz</td><td>Rx</td><td>Ry</td><td>Rz</td><td rowspan="2">
</td></tr>
<tr><td>Yes</td><td>Yes</td><td>No</td><td>No</td><td>No</td><td>Never</td><td>Yes</td><td>Yes</td></tr>
<tr><td colspan="9">WARNING The location of the cone is not locked.</td></tr>
</table>

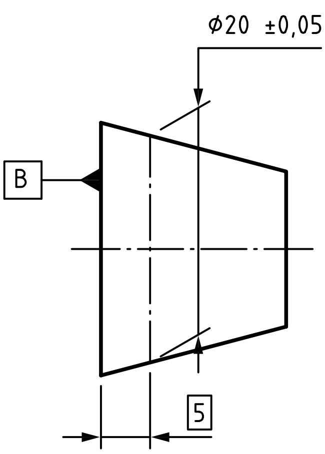
EXAMPLE 6 Cone tolerancing - surface located from a datum system. Secondary datum B is defined perpendicular to primary datum A. The tolerance zone is constrained to be coaxial with datum B (Y = Z = 0) and located so that the section plane, where the diameter of the circular cross section is 30 mm, is placed 20 mm from datum A.

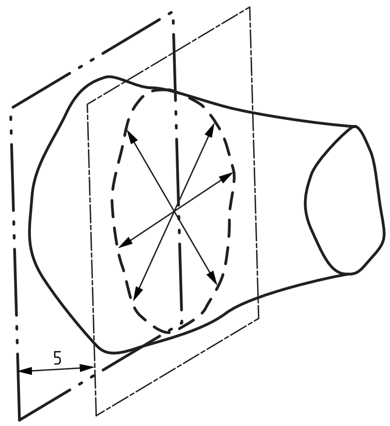
Indication of location specification of the cone surface (with its size considered as fixed) from the datum system	**Meaning**
	The extracted surface of the cone is required to be inside of the tolerance zone with orientation and location constraint from the datum sytem. The axis of the tolerance zone is perpendicular to primary datum A, and the gauge plane, containing the conical section having a diameter 30 mm, is located 20 mm from primary datum A. The axis of the tolerance zone is coaxial to secondary datum B. The tolerance zone is the space between two coaxial conical surfaces with the specified theoretical angle of 30° and 0,3 mm apart. 

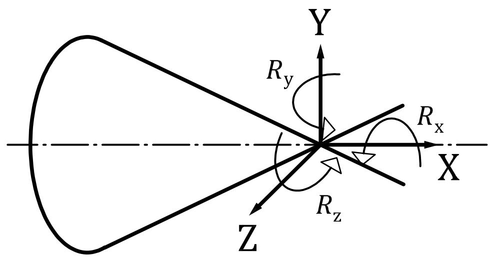
Controlled deviations by the specification								
Angle deviation	Form deviation	Location deviation			Orientation deviation			Illustration of degrees of freedom
		Tx	Ty	Tz	Rx	Ry	Rz	
Yes	Yes	Yes	Yes	Yes	Never	Yes	Yes	
WARNING The form, orientation and location of the cone and its size are locked.								

EXAMPLE 7 Cone tolerancing - circle diameter located on a cross section a fixed distance from one end plane. By default, the GPS characteristic is the local diameter (two point size). Other type of size characteristic can be defined (see ISO 14405-1, e.g. Ø20 ± 0,08 (GG)).

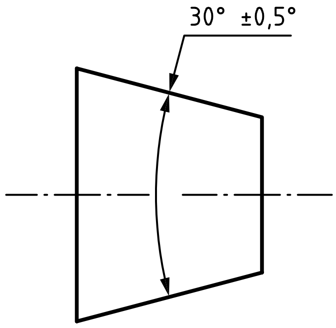
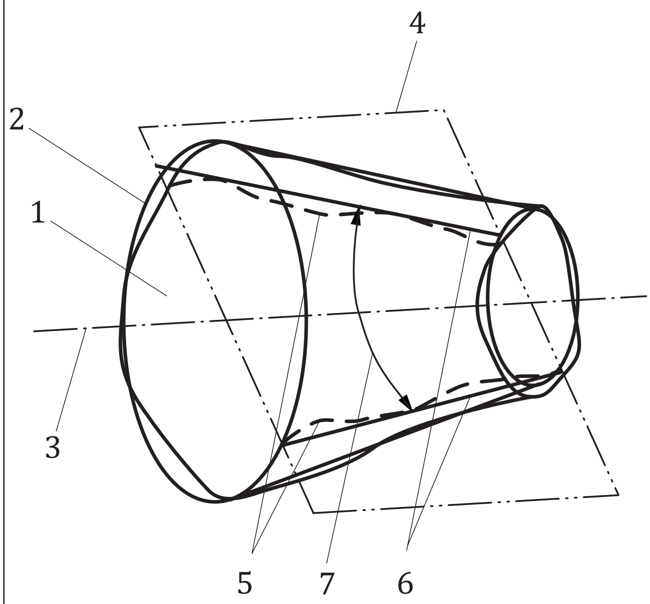
Locating the section plane a distance of 0 mm from the end plane is ambiguous on a real workpiece, due to the possible imperfections of the corner and should be avoided.

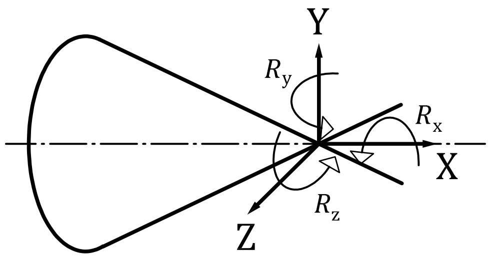
<table>
<tr><th>Indication of location specification of a cone (with its size considered as variable)</th><th>Meaning</th></tr>
<tr><td>

NOTE Without intersection plane indicator, the intersection plane is defined as perpendicular to the axis of the associated cone (feature of angular size) with variable angular size.</td><td>The two-point diameters (as defined in ISO 14405-1) are defined in the intersection plane, parallel from the datum B and located from the left side at 5 mm. The two-point diameters are required to be included between the lower and upper tolerances.

</td></tr>
</table>

<table>
<tr><th colspan="10">Controlled deviations by the specification</th></tr>
<tr><td rowspan="2">Angle deviation</td><td rowspan="2">Form deviation</td><td colspan="3">Location deviation</td><td colspan="3">Orientation deviation</td><td rowspan="2" colspan="2">Illustration of degrees of freedom</td></tr>
<tr><td>Tx</td><td>Ty</td><td>Tz</td><td>Rx</td><td>Ry</td><td>Rz</td></tr>
<tr><td>No</td><td>No</td><td>Yes</td><td>No</td><td>No</td><td>Never</td><td>No</td><td>No</td><td colspan="2">
</td></tr>
<tr><td colspan="10">WARNING The size, the form and the orientation of the cone are not locked. The location of the cone is partially locked in X direction depending of the actual size of the cone.</td></tr>
</table>

EXAMPLE 8 Cone tolerancing - angle between two opposite generatrices. Any local angle, located in any longitudinal section, defined between two contacting straight lines, is required to be within tolerance. A longitudinal section is obtained by a plane that contains the axis of the associated cone (with variable angle) associated with fit to the real cone surface.

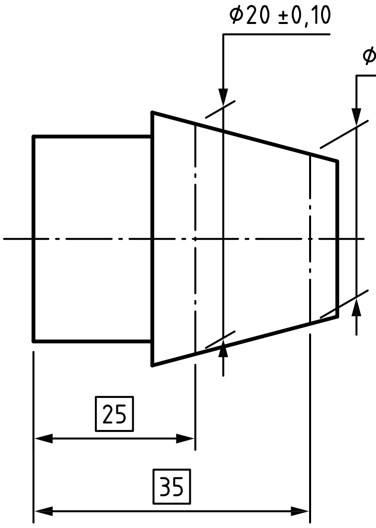
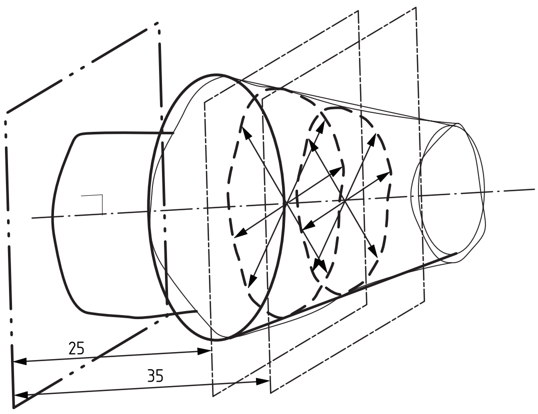
Indication of dimensional angular specification of a cone (with its size considered as variable)	Meaning
 	Any local angle is defined as the angle between two associated coplanar straight lines. These straight lines are established with minimax association criteria constrained outside of material from an extracted pair line resulting of the intersection between the extracted integral surface and any longitudinal plane (that includes the axis of the least-square associated cone with variable size). The local angles are required to be included between the lower and upper tolerances.  **Key** 1 Extracted integral surface 2 Associated cone 3 Cone axis 4 (Example of an) intersection plane 5 (Example of) two extracted lines 6 (Example of) two associated straight lines 7 (Example of a) local angle

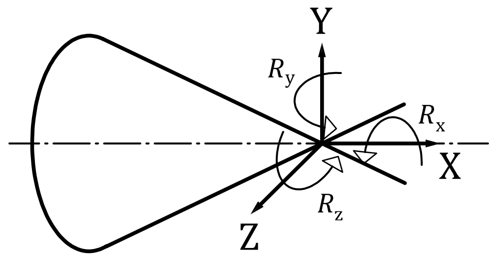
Controlled deviations by the specification								
Angle deviation	Form deviation	Location deviation			Orientation deviation			Illustration of degrees of freedom
		Tx	Ty	Tz	Rx	Ry	Rz	
Yes [a]	No	No	No	No	Never	No	No	

[a] The angle is controlled between two opposite generatrices, and not the angle of the best fit cone.

WARNING The form, orientation and location of the cone are not locked. Only the local size of the cone is locked, since there is no global size modifier indicated (see ISO 14405-3).

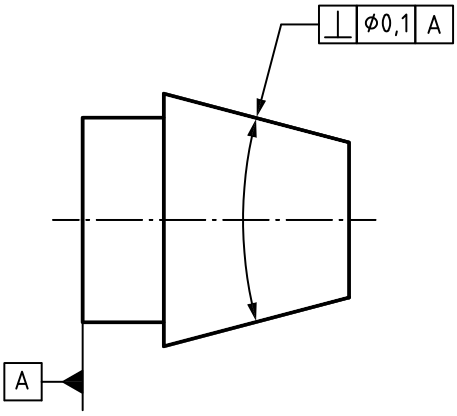
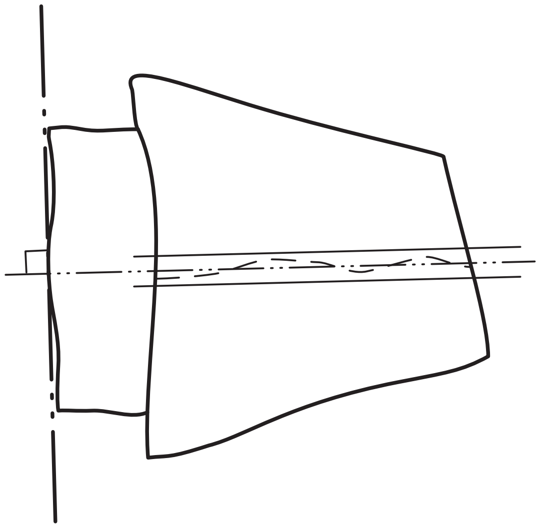
EXAMPLE 9 Cone tolerancing - two diameters of two circles located in two cross sections. By default, the GPS characteristic defining the circular cross section is the local two point size diameter (two point size). Other types of size characteristic can be defined (see ISO 14405-1).

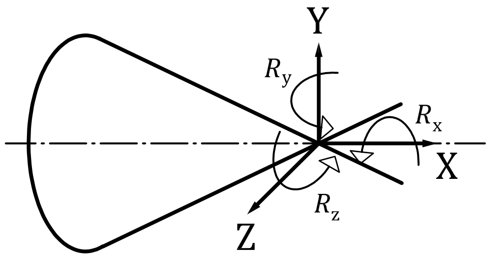
Indication of a set of two dimensional specifications on a cone defined in two specific cross sections	Meaning
	Two dimensional specifications defined in two different specific cross sections from the same conical surface and located from the left side which is by default constrained to be perpendicular to the axis of the associated cone. 

Controlled deviations by the specification								
Angle deviation	Form deviation	Location deviation			Orientation deviation			Illustration of degrees of freedom
		Tx	Ty	Tz	Rx	Ry	Rz	
Yes [a]	No	Yes	No	No	Never	No	No	
[a] The angle control is indirect and is effected by the form.								

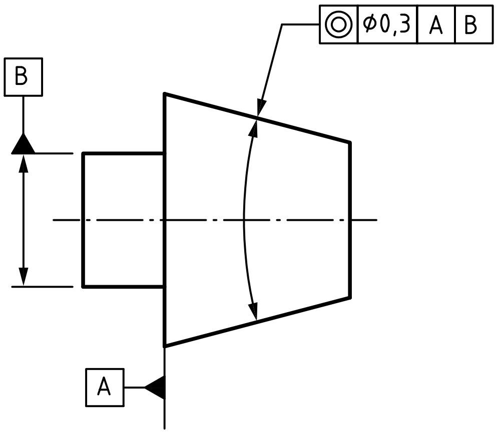
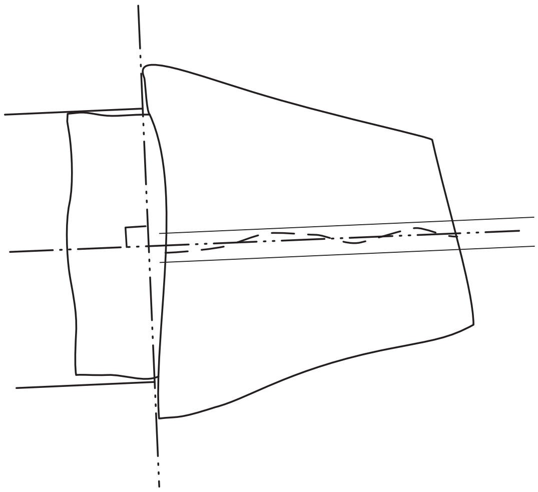
NOTE Specific cross section (SCS) is implicit.

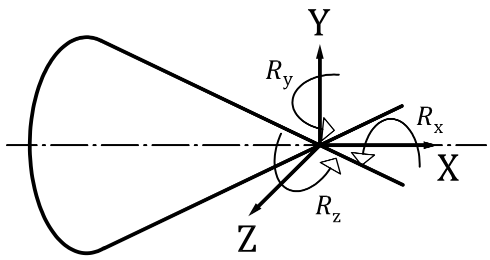
EXAMPLE 10 Cone tolerancing – perpendicularity of the axis of the cone. The tolerance zone which is a cylinder is constrained perpendicular in orientation from the datum A.

Indication of orientation specification of a cone from the datum A without considering its form	**Meaning**
	The extracted median line of the cone is required to be inside of the tolerance zone with orientation constraint from the datum A: the axis of the tolerance zone is constrained perpendicular to the datum A. The tolerance zone consists of the space included into a cylinder of 0,1 mm diameter. 

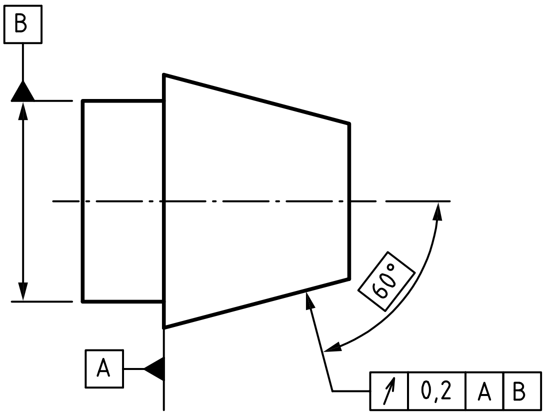
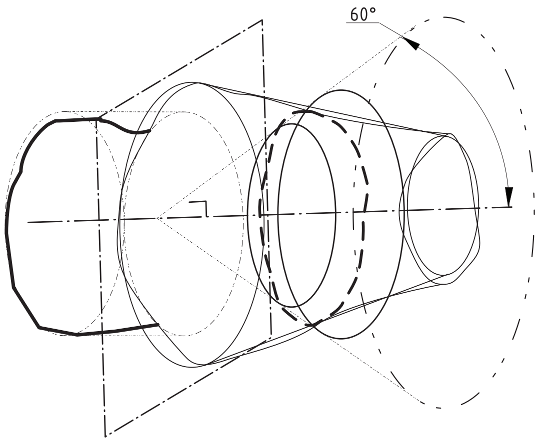
Controlled deviations by the specification								
Angle deviation	Form deviation	Location deviation			Orientation deviation			Illustration of degrees of freedom
		Tx	Ty	Tz	Rx	Ry	Rz	
No	No	No	No	No	Never	Yes	Yes	
WARNING The size, the form and the location of the cone are not locked.								

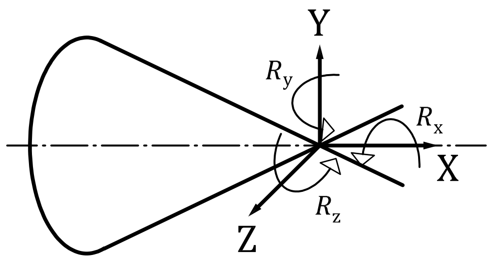
EXAMPLE 11 Cone tolerancing – coaxiality of the extracted median line of a cone from a datum system. The tolerance zone which is a cylinder is constrained to be perpendicular to the datum A and coaxial to datum B.

Indication of location specification of a cone from the datum system	**Meaning**
	The extracted median line of the cone is required to be inside of the tolerance zone with orientation and location constraint from the datum system: the axis of the tolerance zone is constrained perpendicular to the primary datum A and coaxial to the secondary datum B. The tolerance zone consists of the space included into a cylinder of 0,3 mm diameter. 

Controlled deviations by the specification								
Angle deviation	Form deviation	Location deviation			Orientation deviation			Illustration of degrees of freedom
		Tx	Ty	Tz	Rx	Ry	Rz	
No	No	No	Yes	Yes	Never	Yes	Yes	
WARNING The size and the form of the cone are not locked.								

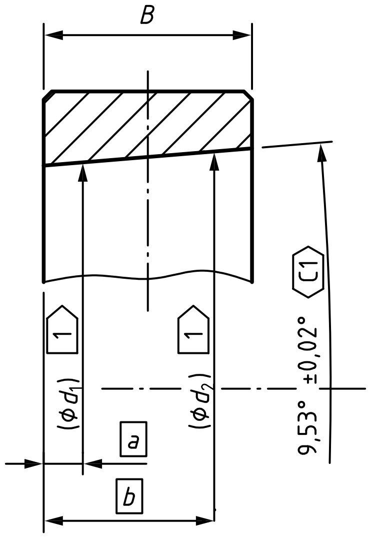
EXAMPLE 12 Cone tolerancing – circular runout of the cone from the datum system. The area between two circles, 0,2 mm apart on a cone, the axis of which is constrained perpendicular to datum A in orientation and coaxial to datum B in location.

Indication of a circular runout specification of a cone surface with considering as its angle as variable	**Meaning**
	Any extracted integral line of the cone is defined as the intersection between the extracted conical surface and an intersecting cone, the axis of which is perpendicular to datum A and coaxial to datum B, and which has an angle of 60°. The tolerance zone consists of the portion area of an intersecting cone limited by two circles, 0,2 mm apart, which are centred on the cone axis. This axis is constrained perpendicular to the datum A and coaxial to the datum B. Any extracted line is required to be inside the tolerance zone. 

Controlled deviations by the specification								
Angle deviation	Form deviation	Location deviation			Orientation deviation			Illustration of degrees of freedom
		Tx	Ty	Tz	Rx	Ry	Rz	
No	Yes	No	Yes	Yes	Never	Yes	Yes	
WARNING The size of the cone is not locked and the location of the cone is partially locked.								

EXAMPLE 13 Cone tolerancing – calculated angle from two diameters of two circles located in two cross-sections (see ISO 14405-1).

<table>
<tr><th>Indication of a calculated angle defined from two dimensional characteristics evaluated in two specific cross sections</th><th>Meaning</th></tr>
<tr><td>



C1 Calculated characteristic from the d_1 and d_2 characteristics

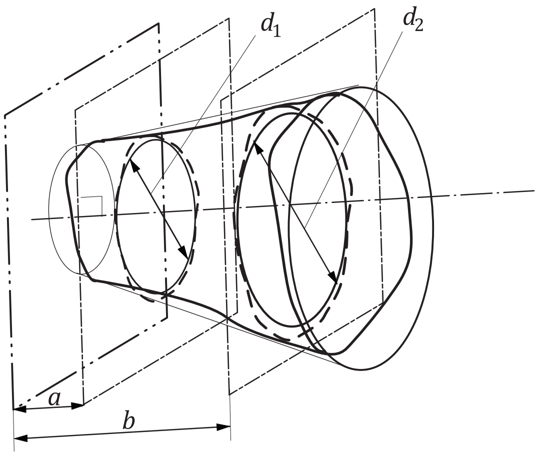
1 Intermediate characteristic evaluated with GX for calculated characteristic C1

</td><td>

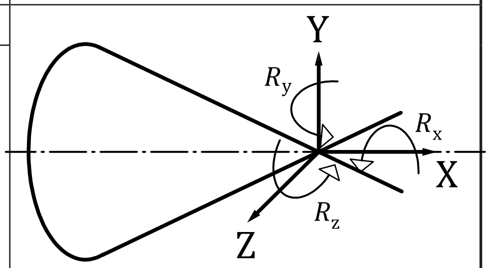
Two linear dimensional characteristics are defined in two different specific cross-sections from the same conical surface and located from the left side. Each linear dimensional characteristic corresponds to the evaluated size of the maximum inscribed circle associated to the extracted line obtained by the intersection of the extracted integral surface of the cone and a specific cross-section.

The calculated characteristic α is the angle derived from these two linear dimensional characteristics d_1 and d_2 and the distances a and b, such as

$$2\tan\left(\frac{\alpha}{2}\right)=\frac{d_2-d_1}{b-a}$$



</td></tr>
</table>

Controlled deviations by the specification								
Angle deviation	Form deviation	Location deviation			Orientation deviation			Illustration of degrees of freedom
		Tx	Ty	Tz	Rx	Ry	Rz	
Yes [a]	No	Yes	No	No	Never	No	No	

a The angle control is indirect and is effected by the form.

Annex B
(informative)

Relation to the GPS matrix model

B.1 General

For full details about the GPS matrix model, see ISO 14638.

B.2 Information about the standard and its use

This International Standard specifies graphical indication applicable to a cone to define its dimensioning or to specify its tolerancing.

B.3 Position in the GPS matrix model

This International Standard is a general GPS standard, which influences chain links A and B of the chain of standards on size, form, orientation, location and run-out, as illustrated in Table B.1

Table B.1 — ISO GPS Standards matrix model

	Chain links						
	A	**B**	**C**	**D**	**E**	**F**	**G**
	Symbols and indications	Feature requirements	Feature properties	Conformance and non-conformance	Measurement	Measurement equipment	Calibrations
Size	•	•					
Distance							
Form	•	•					
Orientation	•	•					
Location	•	•					
Run-out	•	•					
Profile surface texture							
Areal surface texture							
Surface imperfections							

B.4 Related standards

The related standards are those of the chains of standards indicated in Table B.1.

Bibliography

[1] ISO 8015, *Geometrical product specifications (GPS) — Fundamentals – Concepts, principles and rules*

[2] ISO 14253-1, *Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformity or nonconformity with specifications*

[3] ISO 14405-1: —[1], *Geometrical product specifications (GPS) - Dimensional tolerancing — Part 1: Linear sizes*

[4] ISO 14405-3: —[2], *Geometrical product specifications (GPS) - Dimensional tolerancing — Part 3: Angular sizes*

[5] ISO 14638:2015, *Geometrical product specifications (GPS) — Matrix model*

1) To be published.

2) To be published.

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