BS EN ISO 21204:2020

BSI Standards Publication

Geometrical product specifications (GPS) – Transition specification

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Published by BSI Standards Limited 2020

ISBN 978 0 580 94575 5

ICS 17.040.01

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2020.

Amendments/corrigenda issued since publication

Date	Text affected

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 21204

March 2020

ICS 17.040.01

English Version

Geometrical product specifications (GPS) - Transition specification (ISO 21204:2020)

Spécifications géométriques des produits (GPS) - Spécification de transition (ISO 21204:2020)

Geometrische Produktspezifikation (GPS) - Spezifikation von definierten Übergängen zwischen Geometrieelementen (ISO 21204:2020)

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Introduction

This document is a geometrical product specification (GPS) standard and is to be regarded as a general GPS standard (see ISO 14638). It influences chain links A, B and C of the chains of standards on form, orientation and location, see Annex D.

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

In technical drawings, the ideal geometric shape of the workpiece is represented without any deviations and, in general, without consideration of the states of the transitions between adjacent integral features. Nevertheless, for many purposes (the functioning of a part, or out of safety considerations, for example) particular states of transition features need to be indicated. ISO 13715 provides the tools for indicating requirements to edges of undefined shape. These tools are insufficient when the shape of the transition feature is important for functional reasons. Therefore, this document provides a set of tools for indicating transition specifications.

IMPORTANT — Most specification illustrations in this document show edges drawn as sharp corners. They could equally have been drawn showing the nominal geometry of the transition feature, without changing the meaning of the indications. In a computer aided design (CAD) system, the transition feature geometry can be modelled or not without changing the meaning of the indications.

All the specification illustrations in this document show a 90° angle between the two adjacent features. Specifications according to this document have the same meaning, taking the nominal angle into account, regardless of the angle between the two adjacent features.

All figures in this document have been drawn with dimensions and tolerances in millimetres. It should be understood that other units of measurement could have been used equally well without prejudice to the principles established.

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Geometrical product specifications (GPS) — Transition specification

1 Scope

This document defines a number of specification operators for the specification of extended edge transition features between features. An edge transition feature is an integral feature connecting two adjacent integral features. The extended edge transition feature includes portions of the adjacent features. All these specifications apply to any line in a defined direction in the extended edge transition feature. This document also defines the specification modifiers and the drawing indications for such transition specifications.

The proportions and dimensions of the graphical symbols to be used are also specified.

The specifications defined in this document are suitable for relatively simple edge transition functions, for example ensuring assembly without interference. For more complex functions, geometrical tolerancing offers more precise tools.

This document is by intention limited to only edge transition features between two planes and between a cylinder and a plane nominally perpendicular to it.

Annex A gives the first approach for an algorithm to identify toleranced features and adjacent reference sections. This algorithm is subject to change as more experience is gathered.

This document provides a set of tools to express several transition specifications. It does not present any information on the relationship between a function or a use and a transition specification.

NOTE 1 Corners (the transition between three or more features) are not edge transition features and are consequently not covered by this document.

NOTE 2 An edge transition feature exists between two single features. A defined edge transition feature has a defined nominal shape and is not sharp ($r = 0$).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1101:2017, *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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3.1
transition feature
single integral feature connecting two or more adjacent integral surfaces

Note 1 to entry: A single integral feature connecting three or more adjacent integral surfaces (corner) is not covered in this document.

3.2
edge transition feature
single integral feature connecting two adjacent integral surfaces

3.3
extended transition feature
collected integral surface including a transition feature and specified contiguous portions of the adjacent features

3.3.1
extended edge transition feature
collected integral surface including an edge transition feature and specified contiguous portions of the adjacent features

3.3.1.1
extended edge transition section
line resulting from the intersection of an extended edge transition feature with a specified plane

3.4
transition specification
GPS requirement applied to an extended transition feature

3.5
reference portion
line segment in an adjacent feature beyond the extended edge transition section

3.6
adjacent reference section
straight line associated to a reference portion

Note 1 to entry: An adjacent reference section is used as a datum in a transition specification.

3.7
separation point
point separating the search areas for finding the ends of the adjacent features

3.8
specification origin
intersection point between two straight lines established from the adjacent surfaces in an intersection plane defined in a specified direction

Note 1 to entry: See Figure A.4.

3.9
specification direction
direction in which one of the distances defining the toleranced feature and the reference portion applies

4 Basic concepts

An edge transition feature is an areal feature.

Specifications for edge transition features according to this document specify either extended edge transition sections defined in a specified set of intersection planes, where the specification for each

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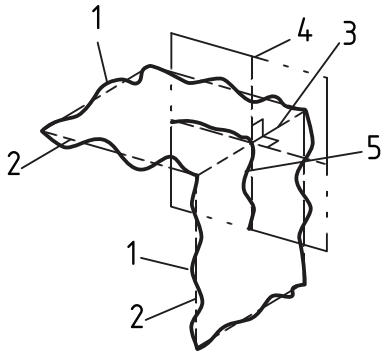
section is independent of the other sections, or collections of such sections, for example a requirement that the radius shall be consistent along the edge transition feature.

By default, transition specifications apply to all extended edge transition sections along the extended edge transition feature.

Figure 1 shows the case where the two adjacent features are planes. The intersection planes that defines the toleranced features are in theoretically exact relationships to the situation feature (straight line) of the collection of associated features adjacent to the edge transition feature. The associations are performed individually to each adjacent feature with the total least squares (Gaussian) criterion. The intersection planes are perpendicular to the intersection straight line between the two associated planes.

The length of the toleranced extended edge transition feature is limited as proposed in A.3.



Key

1 nominally flat real features adjacent to the edge transition feature

2 total least squares (Gaussian) planes associated to 1 independently

3 intersection straight line between 2

4 one of the infinite set of intersection planes perpendicular to 3

5 one of the infinite set of line profiles containing a toleranced extended edge transition section

Figure 1 — Intersection planes defining the toleranced features for an edge transition feature between two planar features

Figure 2 shows the case where one adjacent feature is a plane and the other is a cylinder. In this case the associations are performed simultaneously to the two adjacent features with the constraint that the associated features are perpendicular to each other, like a common datum, but with the total least squares (Gaussian) criterion. The intersection plane contains the axis of the associated cylinder and is also by definition perpendicular to the associated plane.

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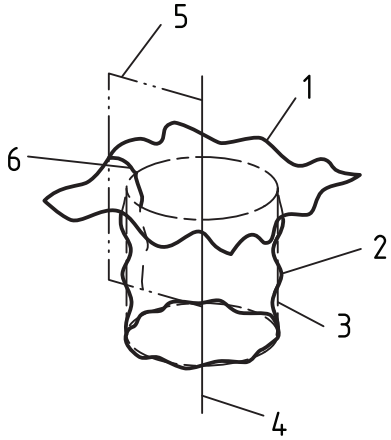

Key

1 nominally flat real feature adjacent to the edge transition feature

2 nominally cylindrical real feature adjacent to the edge transition feature

3 total least squares (Gaussian) cylinder associated to 2

4 axis of 3

5 one of the infinite set of intersection half planes including 4

6 one of the infinite set of line profiles containing a toleranced extended edge transition section

Figure 2 — Intersection planes defining the toleranced features for an edge transition feature between a planar feature and a cylindrical feature

The figures given in Clauses 6 to 9 are not intended to describe the partition. The process of the partitioning of the extended edge transition feature is illustrated in Annex A.

The extent of the reference portions is limited as proposed in A.3. This means that the real surface of the workpiece beyond this extent does not influence the location and orientation for the adjacent reference sections and that material constraints only apply within the defined extent, see, for example, Figure 12 b) where the material constraint does not apply beyond the extent of the reference portion.

If the intersection between the intersection plane and the adjacent feature is not nominally straight, a suitable shape, for example a circle, shall be associated instead with the relevant shape and size parameters being variable in the association, see A.1.

Adjacent reference sections are associated to the reference portions of the adjacent features using the L2 norm with the constraint outside the material, except for least material boundaries, where the L2 norm with the constraint inside the material is used.

Annex B shows an example of approximately equivalent specification of an extended edge transition feature using a geometrical specification.

5 General indication rules

5.1 Symbols

The basic transition specification symbol is shown in Figure 3. The reference line of the symbol shall always be indicated horizontally on the drawing, as shown in Figure 3.

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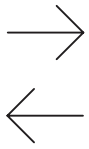

Figure 3 — Basic transition specification indicator

A leader line shall be used to connect the basic symbol to the toleranced feature, see Figure 4. The leader line shall be terminated (using an arrow or a dot) according to the rules specified in ISO 1101.

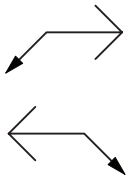

Figure 4 — Transition specification indicator with leader line

The dimensions of the transition specification indicator shall be as shown in Annex C. The description for each symbol used in transition specifications and the clause where they are defined are shown in Table 1.

Table 1 — Symbols for transition specification indications and their meaning

Letter	Description	Clause
C	chamfer	7.1
CF	chamfer of consistent (fixed) dimensions	7.3
CL	chamfer least material boundary	7.5, 7.8
CM	chamfer maximum material boundary	7.4, 7.8
D	extent of the toleranced feature from the specification origin	10.2
E	ellipse	8.1
EF	ellipse of consistent (fixed) dimensions	8.3
EL	ellipse least material boundary	8.5, 8.8
EM	ellipse maximum material boundary	8.4, 8.8
P	fixed profile defined by CAD	9.1
PL	profile defined by CAD least material boundary	9.3
PM	profile defined by CAD maximum material boundary	9.2
R	radius	6.1
RF	radius of consistent (fixed) value	6.3
RL	radius least material boundary	6.5, 6.8
RM	radius maximum material boundary	6.4, 6.8
T	(profile) tolerance value	6, 7, 8, 9
UZ	(profile) tolerance zone offset	10.4

5.2 Indications using the transition specification symbol

5.2.1 General

A transition specification may be indicated in a side view directly on an edge, if the transition feature is not modelled, see Figure 5 a) and b), or on the transition feature itself, see Figure 5 c) and d).

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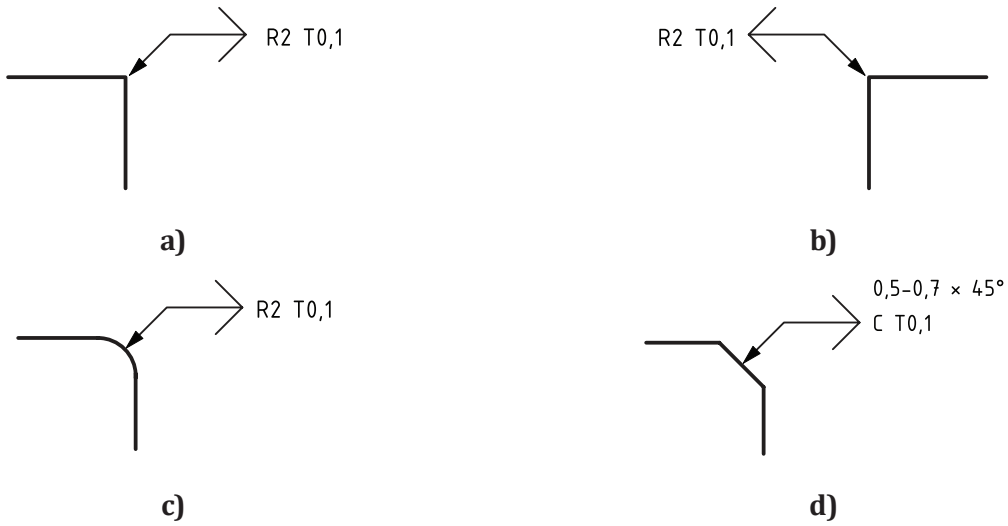


Figure 5 — Side view indications using the transition specification symbol

5.2.2 Indications in face view

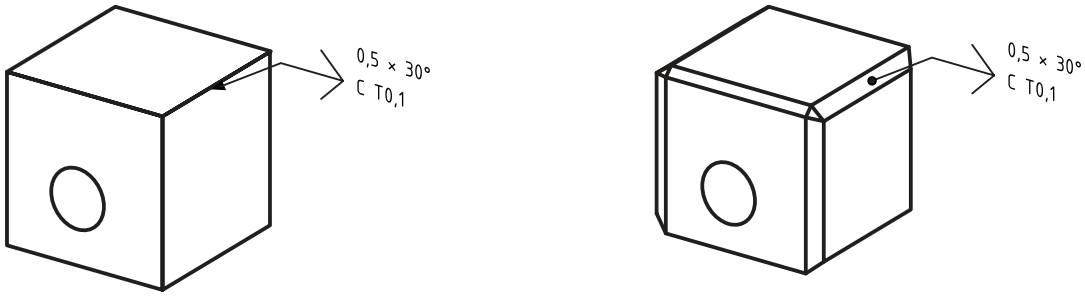
A transition specification may be indicated in a face view directly on an edge, if the transition feature is not modelled, see Figure 6 a), or on the transition feature itself, see Figure 6 b). In this case, the indication in the upper indication area applies to the feature in face view (the plane in Figure 6).

a) Transition feature not modelled **b) Transition feature modelled**

Figure 6 — Face view indications using the transition specification symbol

5.2.3 Indications in 3D

A transition specification may be indicated in 3D directly on an edge, if the transition feature is not modelled, see Figure 7 a), or on the transition feature itself, see Figure 7 b).



a) Transition not modelled **b) Transition modelled**

Figure 7 — 3D indications using the transition specification symbol

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The leader line of a transition specification indicated on a modelled transition feature shall terminate in the middle part of the modelled transition feature, clearly separated from its transition points to the two adjacent features.

A transition specification on one or both transition points on a modelled chamfer may only be specified with a transition specification (defined according to this standard or undefined according to ISO 13715) if the surface of the chamfer is specified by other means, for example a surface or line profile specification according to ISO 1101.

5.3 Indication areas around the transition specification symbol

Letter symbols, numbers that indicate the nominal profile and the tolerance values and other symbols shall be indicated in five areas around the transition specification symbol, see Figure 8. Indications in the centre area apply to the transition feature in general or symmetrically. Indications in the upper and lower areas apply to the adjacent feature or in the direction of the adjacent feature on the same side of the terminator of the leader line, see Figure 8. These rules also apply in 3D. For indications in face view, the indications in the upper areas refer to the adjacent feature in face view and the indications in the lower areas refer to the other adjacent feature.

CAD systems shall be able to adjust the indications, as the view is rotated.

a) b)

Key

1 centre indication area
2 upper main indication area
3 lower main indication area
4 upper primary reference section indication area (see 10.5)
5 lower primary reference section indication area (see 10.5)
6 adjacent feature that indications in 2 and 4 refer to
7 adjacent feature that indications in 3 and 5 refer to

Figure 8 — Indication areas around the transition specification symbol

When there is more than one string of information in a main indication area, they shall be separated by a space, see, for example, Figure 9.

Strings of information belonging together and given in more than one line shall be left aligned under each other, see, for example, Figure 42.

6 Circular edge transition feature indications

6.1 Fixed radius profile specification

When the nominal profile of the edge transition section is circular with a fixed radius, with its centre located to ensure continuity with the adjacent features, and the specification requires the extended

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edge transition section to be within a tolerance zone of a defined width, the indication shall follow the template in Figure 9.

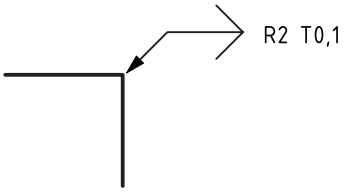
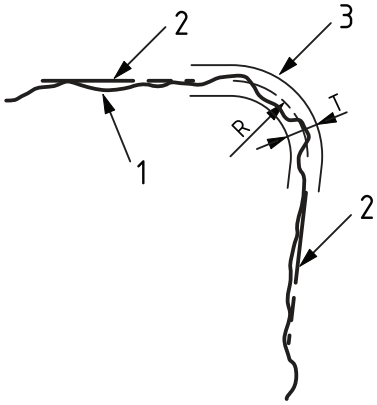


Figure 9 — Radius profile specification

The meaning of the indication in Figure 9 is that the radius of the nominal profile is 2 and the width of the tolerance zone is 0,1. The tolerance zone is symmetrical around the nominal profile, see Figure 10.



Key

1 real workpiece/skin model

2 adjacent reference sections (L2 norm outside the material)

3 tolerance zone

R nominal radius of the transition profile

T tolerance value for the transition tolerance

Figure 10 — Tolerance zone defined by the specification in Figure 9

6.2 Variable radius profile specification

When the nominal profile of the edge transition section is circular, with a radius of any value within a range, with its centre located to ensure continuity with the adjacent features, and the specification requires the extended edge transition section to be within a tolerance zone of a defined width around the actual radius, extended by straight lines, the indication shall follow one of the templates in Figure 11.

a) **b)**

Figure 11 — Variable radius profile specification

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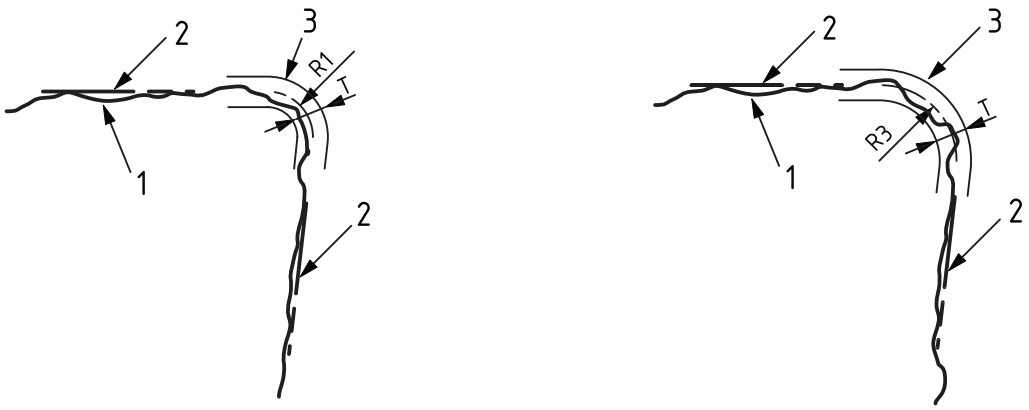
The meaning of the indication in Figure 11 is that the radius of the nominal profile in each cross section may be any value between 1 and 3 and the width of the tolerance zone is 0,1. The tolerance zone is symmetrical around the actual profile radius, see Figure 12.



a) Minimum radius **b) Maximum radius**

Key

1 real workpiece/skin model

2 adjacent reference sections (L2 norm outside the material)

3 tolerance zone

T tolerance value for the transition tolerance

Figure 12 — Tolerance zone defined by the specification in Figure 11

6.3 Consistent radius profile specification

When the nominal profile of the edge transition section is circular, with a radius of any value within a range, with its centre located to ensure continuity with the adjacent features, and the specification requires the extended edge transition section to be within a tolerance zone of a defined width around the actual radius and with the additional requirement that the radius shall be the same for all cross sections of the edge transition feature, the indication shall follow one of the templates in Figure 13.

a) **b)**

Figure 13 — Consistent radius profile specification

The meaning of the indication in Figure 13 is that the radius of the nominal profile may be any value between 1 and 3, but shall be the same (fixed) value for all cross sections of the transition. The width of the tolerance zone is 0,1. The tolerance zone is symmetrical around the actual profile radius, see Figure 12.

NOTE The difference between the specifications in Figure 11 and Figure 13 is that the specification in Figure 11 allows the radius in each cross section to be any value within the specified range, independent of the other cross sections, whereas the specification in Figure 13 requires all cross sections to have the same unique value from within the specified range.

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6.4 Maximum material radius boundary specification

When the extended edge transition section is contained by a maximum material circular boundary of a defined radius, extended by straight lines, the indication shall follow the template in Figure 14.

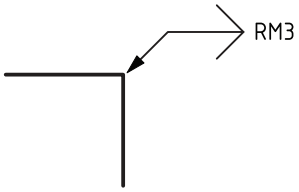
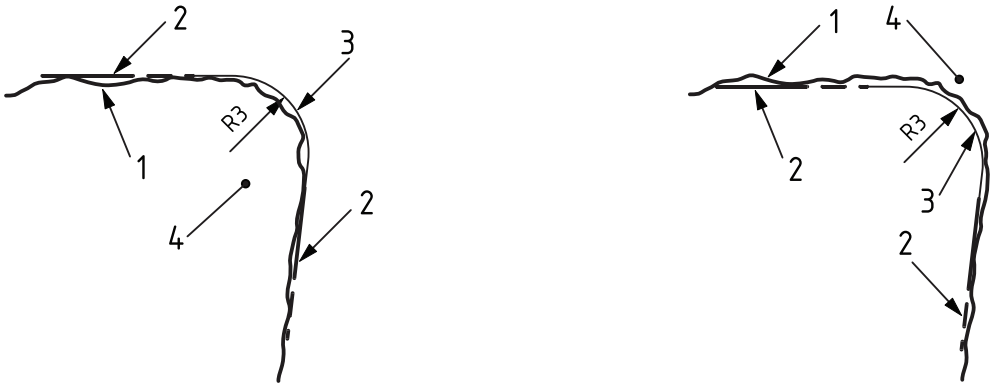


Figure 14 — Maximum material radius boundary specification

The meaning of the indication in Figure 14 is that the extended edge transition section shall be contained by a maximum material circular boundary of radius 3, extended by straight lines, continuous with the adjacent reference sections, see Figure 15.

NOTE This is a one-sided tolerance that does not constrain the edge transition feature in the least material direction.



a) External transition **b) Internal transition**

Key

1 real workpiece/skin model

2 adjacent reference sections (L2 norm outside the material)

3 limiting maximum material boundary

4 material side

Figure 15 — Limiting maximum material boundary defined by the specification in Figure 14

6.5 Least material radius boundary specification

When the extended edge transition section contains a least material circular boundary of a defined radius, extended by straight lines, the indication shall follow the template in Figure 16.

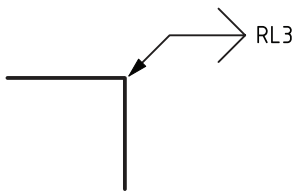


Figure 16 — Least material radius boundary specification

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The meaning of the indication in Figure 16 is that the edge transition section shall contain a least material circular boundary of radius 3, extended by straight lines, continuous with the adjacent reference sections, see Figure 17.

NOTE This is a one-sided tolerance that does not constrain the edge transition feature in the maximum material direction.

a) External transition **b) Internal transition**

Key

1 real workpiece/skin model

2 adjacent reference sections (L2 norm inside the material)

3 limiting least material boundary

4 material side

Figure 17 — Limiting least material boundary defined by the specification in Figure 16

6.6 Maximum material radius boundary with profile specification

When the extended edge transition section is contained by a maximum material circular boundary of a defined radius, extended by straight lines, and the extended edge transition section is required to be within a tolerance zone of a defined width inside the extended circular boundary, the indication shall follow the template in Figure 18.

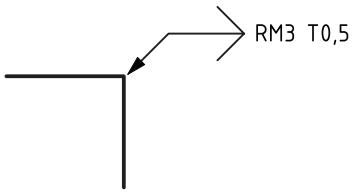

Figure 18 — Maximum material radius boundary with profile specification

The meaning of the indication in Figure 18 is that the extended edge transition section shall be contained by a maximum material circular boundary of radius 3, extended by straight lines, continuous with the adjacent reference sections, and the extended edge transition section shall be within a 0,5-wide tolerance zone inside the extended circular boundary, see Figure 19.

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