TECHNICAL SPECIFICATION

ISO/TS 13399-312

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Cutting tool data representation and exchange —

Part 312: Creation and exchange of 3D models — Reamers for indexable inserts

Représentation et échange des données relatives aux outils coupants —

Partie 312: Création et échange des modèles 3D — Alésoirs à plaquettes amovibles

Reference number
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Foreword

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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).

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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 WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 29, *Small tools*.

ISO/TS 13399 consists of the following parts, under the general title *Cutting tool data representation and exchange*:

— *Part 1: Overview, fundamental principles and general information model*

— *Part 2: Reference dictionary for the cutting items* [Technical Specification]

— *Part 3: Reference dictionary for tool items* [Technical Specification]

— *Part 4: Reference dictionary for adaptive items* [Technical Specification]

— *Part 5: Reference dictionary for assembly items* [Technical Specification]

— *Part 50: Reference dictionary for reference systems and common concepts* [Technical Specification]

— *Part 60: Reference dictionary for connection systems* [Technical Specification]

— *Part 80: Creation and exchange of 3D models — Overview and principles* [Technical Specification]

— *Part 100: Definitions, principles and methods for reference dictionaries* [Technical Specification]

— *Part 150: Usage guidelines* [Technical Specification]

— *Part 201: Creation and exchange of 3D models — Regular inserts* [Technical Specification]

— *Part 202: Creation and exchange of 3D models — Irregular inserts* [Technical Specification]

— *Part 203: Creation and exchange of 3D models — Replaceable inserts for drilling* [Technical Specification]

— *Part 204: Creation and exchange of 3D models — Inserts for reaming* [Technical Specification]

— *Part 301: Concept for the design of 3D models based on properties according to ISO/TS 13399-3: Modelling of thread-cutting taps, thread-forming taps and thread-cutting dies* [Technical Specification]

- *Part 302: Concept for the design of 3D models based on properties according to ISO/TS 13399-3: Modelling of solid drills and countersinking tools* [Technical Specification]
- *Part 303: Concept for the design of 3D models based on properties according to ISO/TS 13399-3: Modelling of end mills with solid cutting edges* [Technical Specification]
- *Part 304: Concept for the design of 3D models based on properties according to ISO/TS 13399-3: Modelling of milling cutters with arbor hole and solid cutting edges* [Technical Specification]
- *Part 307: Creation and exchange of 3D models — End mills for indexable inserts* [Technical Specification]
- *Part 308: Creation and exchange of 3D models — Milling cutters with arbor hole for indexable inserts* [Technical Specification]
- *Part 309: Creation and exchange of 3D models — Tool holders for indexable inserts* [Technical Specification]
- *Part 311: Creation and exchange of 3D models — Solid reamers* [Technical Specification]
- *Part 312: Creation and exchange of 3D models — Reamers for indexable inserts* [Technical Specification]
- *Part 401: Creation and exchange of 3D models — Converting, extending and reducing adaptive items* [Technical Specification]
- *Part 405: Creation and exchange of 3D models — Collets* [Technical Specification]

The following parts are under preparation:

- *Part 70: Graphical data layout — Layer settings for tool designs* [Technical Specification]
- *Part 71: Graphical data layout — Creation of documents for the standardized data exchange — Graphical product information* [Technical Specification]
- *Part 72: Creation of documents for the standardized data exchange — Definition of properties for drawing header and their XML-data exchange* [Technical Specification]
- *Part 305: Creation and exchange of 3D models — Modular tooling systems with adjustable cartridges for boring* [Technical Specification]
- *Part 310: Creation and exchange of 3D models — Turning tools with carbide tips* [Technical Specification]

Introduction

This part of ISO/TS 13399 defines the concept, the terms and the definitions on how to design simplified 3D models of reamers for indexable cutting edges that can be used for NC-programming, simulation of the manufacturing processes and the determination of collision within machining processes. It is not intended to standardize the design of the cutting tool itself.

A cutting tool is used in a machine to remove material from a workpiece by a shearing action at the cutting edges of the tool. Cutting tool data that can be described by ISO/TS 13399 (all parts) include, but are not limited to, everything between the workpiece and the machine tool. Information about inserts, solid tools, assembled tools, adaptors, components and their relationships can be represented by ISO/TS 13399 (all parts). The increasing demand providing the end-user with 3D models for the purposes defined above is the basis for the development of this series of International Standards.

The objective of ISO/TS 13399 (all parts) is to provide the means to represent the information that describes cutting tools in a computer sensible form that is independent from any particular computer system. The representation will facilitate the processing and exchange of cutting tool data within and between different software systems and computer platforms and support the application of this data in manufacturing planning, cutting operations and the supply of tools. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and for archiving. The methods that are used for these representations are those developed by ISO/TC 184 for the representation of product data by using standardized information models and reference dictionaries.

Definitions and identifications of dictionary entries are defined by means of standard data that consist of instances of the EXPRESS entity data types defined in the common dictionary schema, resulting from a joint effort between ISO/TC 184/SC 4 and IEC/TC 3/SC 3D and in its extensions defined in ISO 13584-24 and ISO 13584-25.

Cutting tool data representation and exchange —

Part 312:
Creation and exchange of 3D models — Reamers for indexable inserts

1 Scope

This part of ISO/TS 13399 specifies a concept for the design of tool items, limited to any kind of reamers for indexable cutting edges, together with the usage of the related properties and domains of values.

This part of ISO/TS 13399 specifies a common way of design simplified models that contain the following:

— definitions and identifications of the design features of reamers for indexable cutting edges, with an association to the used properties;

— definitions and identifications of the internal structure of the 3D model that represent the features and the properties of reamers for indexable cutting edges.

The following are outside the scope of this part of ISO/TS 13399:

— applications where these standard data may be stored or referenced;

— concept of 3D models for cutting tools;

— concept of 3D models for cutting items;

— concept of 3D models for other tool items not being described in the scope of this part of ISO/TS 13399;

— concept of 3D models for adaptive items;

— concept of 3D models for assembly items and auxiliary items.

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/TS 13399-3, *Cutting tool data representation and exchange — Part 3: Reference dictionary for tool items*

ISO/TS 13399-4, *Cutting tool data representation and exchange — Part 4: Reference dictionary for adaptive items*

ISO/TS 13399-50:2013, *Cutting tool data representation and exchange — Part 50: Reference dictionary for reference systems and common concepts*

ISO/TS 13399-60, *Cutting tool data representation and exchange — Part 60: Reference dictionary for connection systems*

ISO/TS 13399-80, *Cutting tool data representation and exchange — Part 80: Creation and exchange of 3D models — Overview and principles*

ISO/TS 13399-204, *Cutting tool data representation and exchange — Part 204: Creation and exchange of 3D models — Inserts for reaming*

3 Starting elements, coordinate systems, planes

3.1 General

The modelling of the 3D models shall be done by means of nominal dimensions.

WARNING — There is no guarantee that the 3D model, created according to the methods described in this part of ISO/TS 13399, is a true representation of the physical tool supplied by the tool manufacturer. If the models are used for simulation purposes, for example, CAM simulation, it shall be taken into consideration that the real product dimensions can differ from those nominal dimensions.

NOTE Some definitions are taken from ISO/TS 13399-50.

3.2 Reference system

The reference system, as shown in Figure 1, consists of the following standard elements:

— **standard coordinate system:** right-handed rectangular Cartesian system in three-dimensional space, called “primary coordinate system” (PCS);

— **3 orthogonal planes:** planes in the coordinate system that contain the axis of the system, named “xy-plane” (XYP), “xz-plane” (XZP) and “yz-plane” (YZP);

— **3 orthogonal axis:** axes built as intersections of the three orthogonal planes lines respectively, named “x-axis” (XA), “y-axis” (YA) and “z-axis” (ZA).

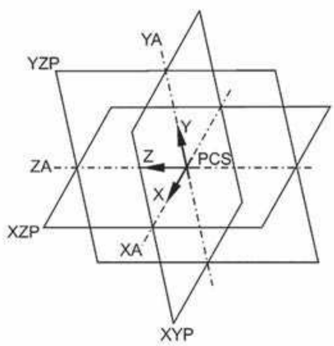

Figure 1 — Reference system

3.3 Primary coordinate system and mounting coordinate system

The location of the primary coordinate system (PCS) within the 3D model shall be defined unambiguously. The position of the PCS is given for all connection interfaces in accordance with ISO/TS 13399-50:2013, 5.2 and Figures F.4 to F.9. Subsequently, the PCS is located at the gage line, if connection interfaces with defined gage line are used, e.g. hollow taper shank, hollow polygonal taper or taper with ball track system. At shanks without defined gage line, the PCS is positioned at the end of the shank.

For virtually mounting of reamers onto an adaptive item, an additional reference system shall be defined. This reference system is called “mounting coordinate system” (MCS). It is located at the starting point of the protruding length of a tool item. The orientation is shown in Figure 2.

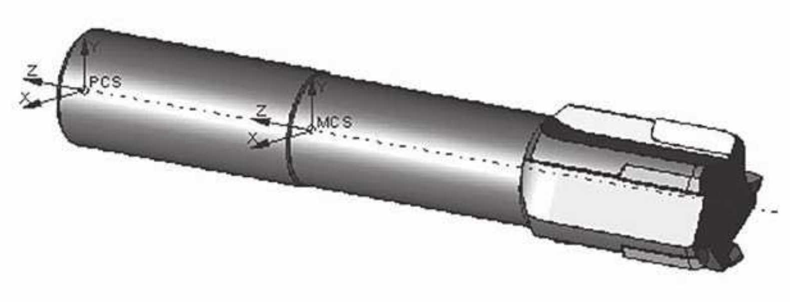

Figure 2 — Orientation of “PCS” and “MCS” reference system (example)

3.4 Coordinate system at the cutting part

The coordinate system at the cutting part shown in Figure 3, e.g. the planar front face, named “coordinate system in process” (CIP), with a defined distance to the PCS shall be oriented as follows:

— z-axis of CIP points to the PCS;

— z-axis of CIP is collinear to the z-axis of PCS;

— y-axis of CIP is parallel to the y-axis of PCS.

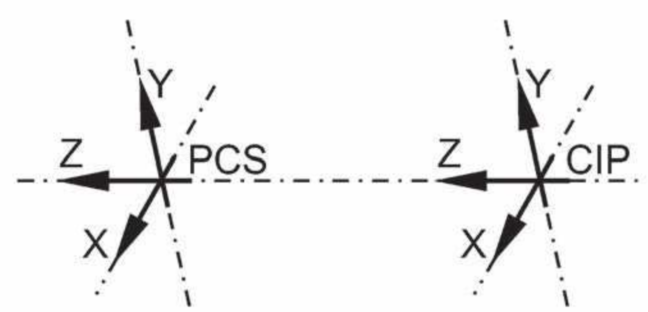

Figure 3 — Orientation of CIP

If the 3D modelling software gives the possibility to include interfaces for components, e.g. to mount a face cutting part onto a complete cutting tool, it shall be advised to use the coordinate system “CIP”.

If necessary, another designation shall be given to the interface of the component (dependent on the software). The name is “CSIF” (for “coordinate system interface”) and includes the coordinate system “CIP”.

3.5 Planes

The modelling shall take place based on planes according to Figure 4 and it shall be used as reference, if applicable. Therefore, the model shall be able to vary or single features of independent design features shall be deleted by means of changing the value of one or more parameter of the model design. Furthermore, the identification of the different areas shall be simplified in using the plane concept, even if they contact each other with the same size, e.g. chip flute, shank.

For the 3D visualization of reamers with non-indexable cutting edges, the planes shall be determined as follows:

— “TEP” plane located at the end of the interface on the machine side with reference to “CIP”; the distance between “CIP” and “TEP” is the property “OAL” (overall length);

— “LPRP” plane for the protruding length (LPR), based on “CIP”;

— “LSP” plane for the shank length (LS), based on “TEP”;

— “LUP” plane for the usable length (LU), based on “CIP”;

— “SDP_n” plane for the step distance (SD), based on “CIP”. This plane shall be indexed by means of number of steps;

— “SDLP_1” plane for the step diameter length (SDL), based on each starting point of the individual step. The first step diameter length is based on the plug;

— “PLGLP” plane for the plug length (PLGL), based on “CIP”;

— “HEP” plane located at the front of the tool and is coplanar with the XY-plane of “CIP”.

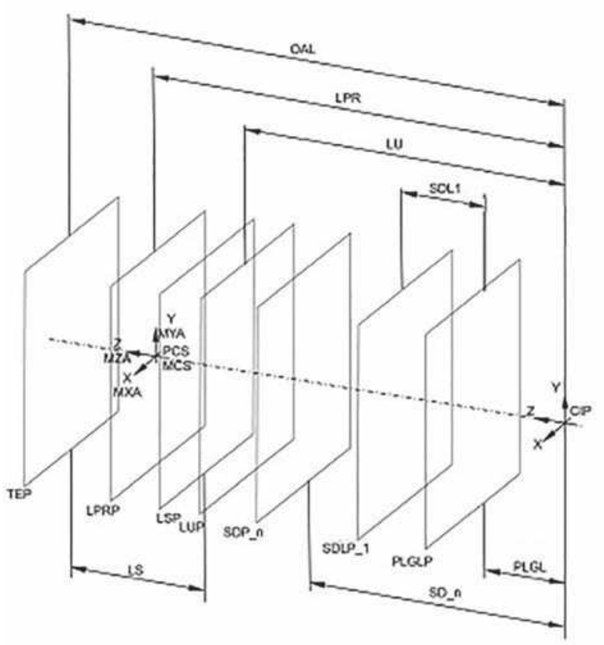

Figure 4 — Planes for design

3.6 Design of the pocket seat and cutting reference point (CRP) of the insert

If inserts for reaming have a specific design and are not interchangeable between vendors, the location of the MCS shall be upon the manufacturer’s discretion, either on the top face or on the bottom face. The orientation of the axis shall follow the definitions in this part of ISO/TS 13399.

The final position of the pocket seat shall be designed by means of designing an insert. This feature shall be used for subtraction from the tool body. To give the possibility to use inserts with different corner configurations, only that corner defining the functional dimensions shall carry the corner configuration. The remaining corners shall be designed without a corner configuration.

MCS-coordinate system of the insert (MCS_INS) and the PCS-coordinate system of the insert (PCS_INS) are oriented differently to the primary coordinate system of the tool (PCS_TOOL). The orientation is shown in Figure 5.

The neutral position of an insert is determined as follows:

— the origin of the MCS_INS and the origin of the PCS_INS are identical;

— the x-axis of PCS_INSERT shall be collinear to the x-axis of PCS_TOOL;

— the y-axis of PCS_INSERT shall be collinear to the z-axis of PCS_TOOL;

— the z-axis of PCS_INSERT shall be collinear to the y-axis of PCS_TOOL.

Positioning of the insert into the functional location shall be done as follows.

a) Design with side cutting edge angle on a right handed tool, commonly used on the periphery of the reamer, typically for all kind of side cutting end mills.

   1) Only those inserts shall be used that are located in the first quadrant of the primary coordinate system of the insert, also called “right handed” or “neutral” inserts.

   2) The insert shall be rotated by KAPR degrees in mathematic positive direction (counter-clockwise) about the y-axis of PCS_TOOL.

   3) The cutting reference point “CRP” is the point where the functional dimensions are based. The definition of the CRP is given in ISO/TS 13399-50.

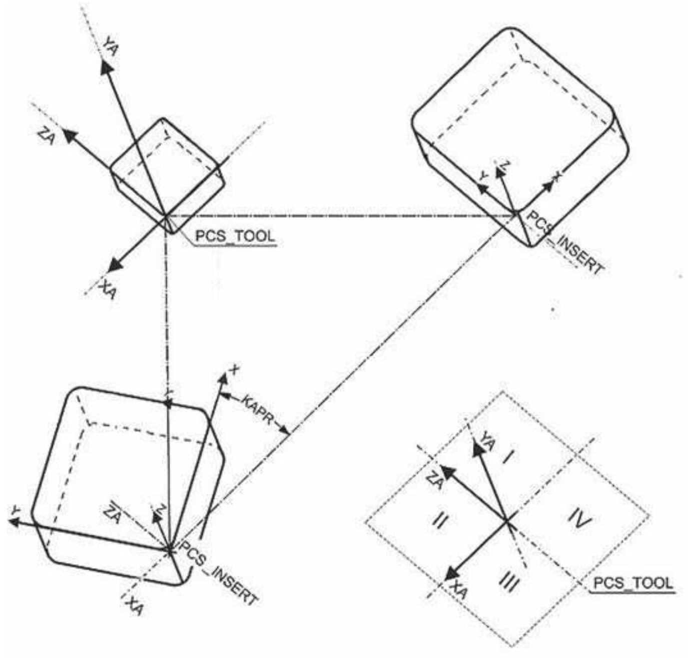

Figure 5 — Orientation of PCS_INSERT, MCS_INSERT and PCS_TOOL on side cutting edge angle

b) If the tool is defined with an axial rake and a radial rake angle that are unequal 0 degree, the insert shall be rotated about its CRP as shown in Figure 6. Therefore, two axis shall be added.

   1) GAMP-axis positioned on CRP with its vector parallel to x-axis of PCS_TOOL defines the rotation of axial rake angle.

   2) GAMF-axis positioned on CRP with its vector parallel to z-axis of PCS_TOOL defines the rotation of radial rake angle.

   3) The position of the C_CRP is defined with the properties DC/2 and LF.

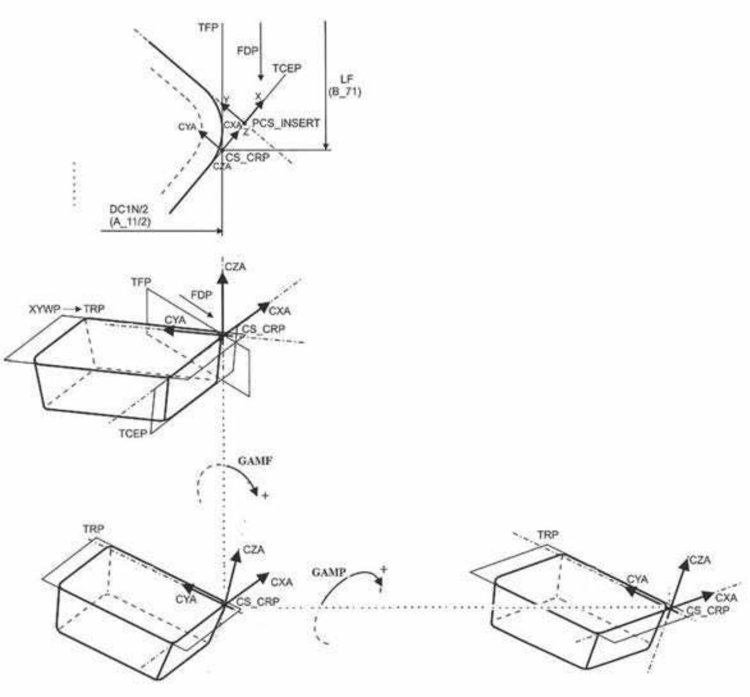

Figure 6 — Axial and radial rake angle on insert

3.7 Adjustment coordinate system on workpiece side

3.7.1 General

Additional coordinate systems for mounting components "CSWx_y" (coordinate system workpiece side) shall be defined according to ISO/TS 13399-50.

3.7.2 Designation of the coordinate system workpiece side

Case 1 One coordinate system at the workpiece side shall be designated as "CSW".

Case 2 One coordinate system at workpiece side on different levels shall be designated as "CSWx", e.g. "CSW1", "CSW2". The numbering starts at the workpiece side and ends at the machine side in the direction of the positive z-axis.

Case 3 Multiple coordinate systems at one level, but different angles and not at the centre of the tool axis, shall be designated with "CSWx_y", where the "x" defines the level and the "y" defines the number of the coordinate system itself. The counting starts at the three o'clock position counting in counter-clockwise direction while looking towards the machine spindle (positive z-axis).

Case 4 Multiple coordinate systems at one level, one angle and different diameters shall be designated as described in Case 3. The counting shall start at the smallest diameter.

Case 5 Multiple coordinate systems at one level, different angles and different diameters shall be designated as described in Case 3. The counting shall start at the smallest diameter and at the three o'clock position counting in counter-clockwise direction while looking towards the machine spindle (positive z-axis).

Figure 7 shows an example of the arrangement of the CSWs.

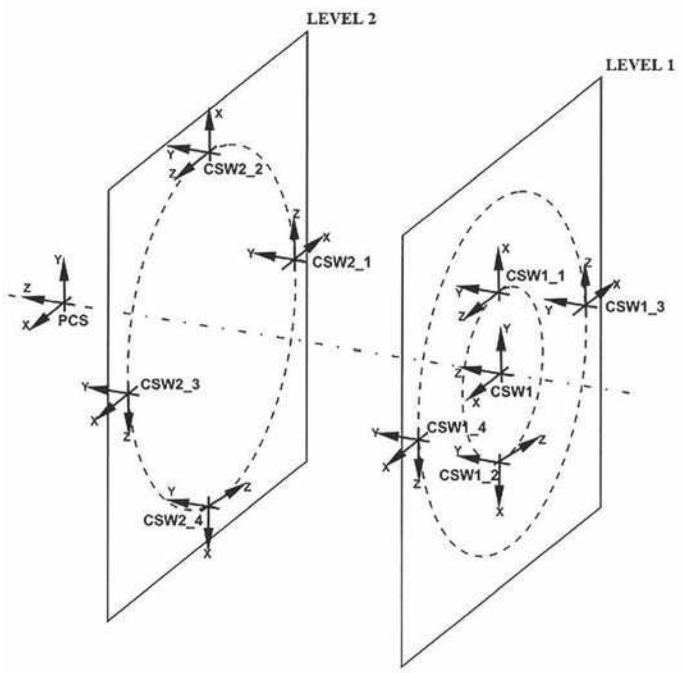

Figure 7 — Adjustment coordinate system on workpiece side

The MCS_INS shall be placed onto the CSWx_y of the tool with determinations as follows and as shown in Figure 8:

— the x-axis of CSWx_y is parallel to the x-axis of CRP;

— the y-axis of CSWx_y is parallel to the y-axis of CRP;

— the z-axis of CSWx_y is parallel to the z-axis of CRP.

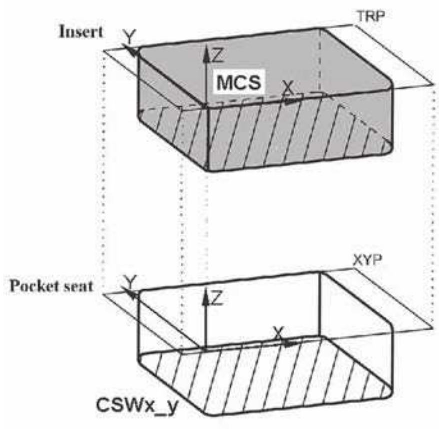

Figure 8 — Mounting of insert onto pocket seat

4 Design of the model

4.1 General

The sketches (outline contour) and features of the crude model may not contain details like slots, chamfers, roundings and grooves. These features shall be designed as separate design elements after the crude geometry and shall be grouped as detail geometry. Based on the non-cutting features (group “NOCUT”), the cutting features shall be loaded as assembly parts (group “CUT”) into the basic model. For the group “DETAILS”, see Clause 10. The sequence of the model structure shall be kept as described. There is no reference between the connection and the basic body. Only the group “DETAILS” may contain references to other design features.

Reamers for indexable inserts shall be designed as rotational features, namely:

— basic geometry containing connection and tool body designed as rotating body;

— geometry of the tool body (chip flute, pocket seat, etc.);

— geometry of the connection;

— details (chamfers, roundings, slots, etc.).

The indexable inserts for reaming shall be incorporated as discrete item_features to the model. Therefore, the references are the CSWs.

The basic shapes of reamers shall be designed with cylindrical shank and positioned onto the PCS.

All examples shall be designed with 0 (zero) degrees axial and radial rake angle.

The total amount of design elements shall be dependent on the level of detail and on the complexity of the cutting tool.

The specific model structure of the different shapes of end mills for indexable inserts shall be described in the next clauses.

4.2 Necessary parameters for the connection interface feature

Information about the connection interface code shall be filled as properties within the model and named as parameters as listed in Table 1:

Table 1 — Parameter list for connection interface feature

Preferred symbol	Description	Source of symbol	ISO-ID number
CCMS	connection code machine side	ISO/TS 13399-3 and ISO/TS 13399−4	71D102AE3B252
CCTMS	connection code type machine side	ISO/TS 13399-60 short name of subtype of connection_interface_feature	feature_class
CCFMS	connection code form machine side	ISO/TS 13399-60 number of the variant of the subtype of connection_interface_feature	feature_class
CZCMS	connection size code machine side	connection size code (dependent of side)	71FC193318002

The information above and other relevant properties shall be incorporated into the model as parameters or shall be taken as a separate file.

4.3 Necessary properties for inserts

4.3.1 General

Necessary properties for the design of the pocket seat features shall be taken in accordance with the defined properties for cutting items (see ISO/TS 13399-2). To be able to differentiate between tool-item and cutting-item properties, a postfix shall be added to the preferred symbols of the cutting-item properties. The postfix has the same code and sequence as the different coordinate systems on workpiece side that are defined in 3.6.

4.3.2 Properties of inserts for reaming operations

Table 2 lists the properties of inserts for reaming.

Table 2 — Properties for pocket seats of inserts for reaming operations

Preferred name	Preferred symbol
clearance angle major	AN
insert length	INSL
plug angle 1[a]	PLGANG1
plug angle 2[a]	PLGANG2
plug length 1[a]	PLGL1
plug length 2[a]	PLGL2
corner radius	RE
insert thickness	S
insert thickness total	S1
insert width	W1

[a] These properties are indexed.

4.3.3 Design of the pocket seat feature

The design shall be done in accordance to ISO/TS 13399-204, but without corner configuration on the opposite side where the functional dimensions are based.

5 Cylindrical reamer

5.1 General

Figure 9 shows the properties to be used for the design of cylindrical reamers.

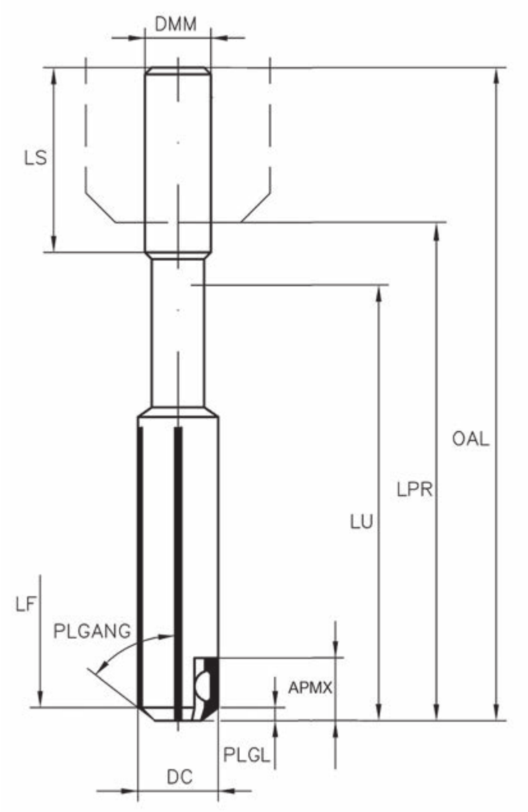

Figure 9 — Determination of properties of cylindrical reamers

5.2 Necessary properties

Table 3 lists the properties that are needed for the modelling of a cylindrical reamer.

Table 3 — Properties for the modelling of a cylindrical reamer

Preferred name	Preferred symbol
cutting edge length, maximum	APMX
cutting edge sequence	CESEQ
cutting diameter	DC
shank diameter	DMM
neck diameter	DN
protruding length	LPR
functional length	LF
shank length	LS
head length	LH
usable length	LU
overall length	OAL
offset chip flute outer pocket	OFFCFEX
plug length	PLGL
plug angle	PLGANG
chip flute radius	RCF

For the design of reamers, the number of effective cutting edges for each cutting step is necessary. Therefore, a new property shall be added to the dictionary.

5.3 Basic geometry

The basic of that part is a rotational design feature which contains all elements between the plane “TEP” und the plane “HEP” at the coordinate system “CIP”.

The sketch includes all the elements above and shall be designed on the YZ plane of the “PCS”. The rotational axis is the standard z-axis.

The design of the sketch shall be as follows.

— The sketch shall be determined as a half section.

— The sketch shall be constrained to the coordinate system “PCS” and to the planes “TEP” and “HEP” according to Figure 10. If the CAD software does not support the use of datum planes, the sketch shall be fully dimensioned. Otherwise, the distances shall be in conjunction with the defined datum planes.

— The dimensioning shall be done with the appropriate properties listed in Table 3 and illustrated in Figure 10.

The sketch shall be revolved about the z-axis by 360°.

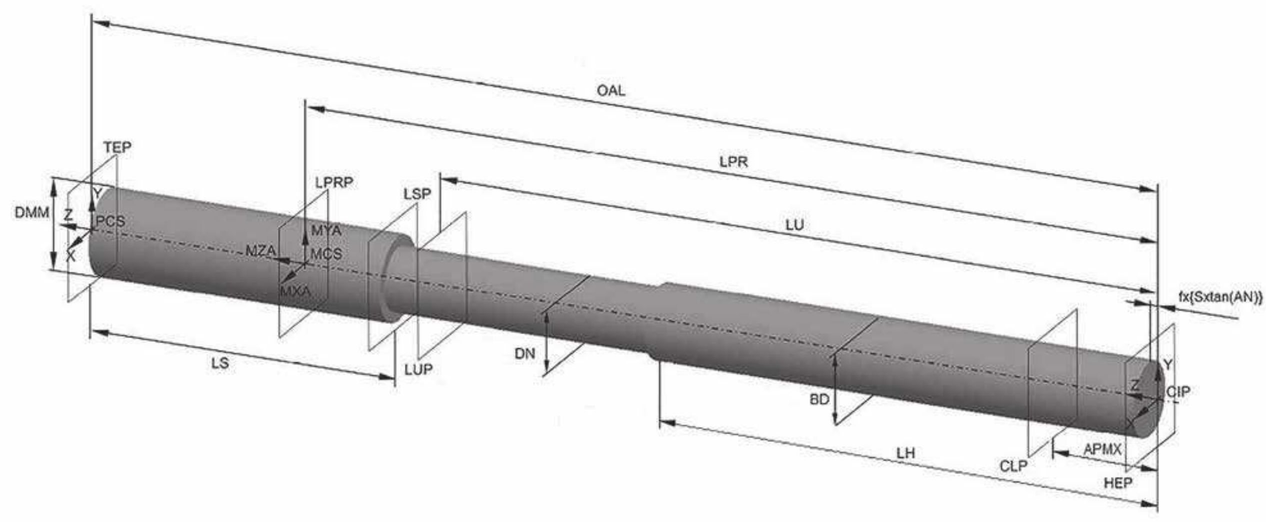

Figure 10 — Basic geometry of a cylindrical reamer

5.4 Determination of the position of the mounting coordinate system of insert

A coordinate system workpiece side and the corresponding planes shall be determined for each insert in accordance to the definitions in ISO/TS 13399-50.

The coordinate systems “CSWx_y” shall be referenced to “PCS” as shown in Figure 11. The position is determined through the following:

— the dimensions DC, LF;

— the geometry of the insert;

— the cutting reference point.

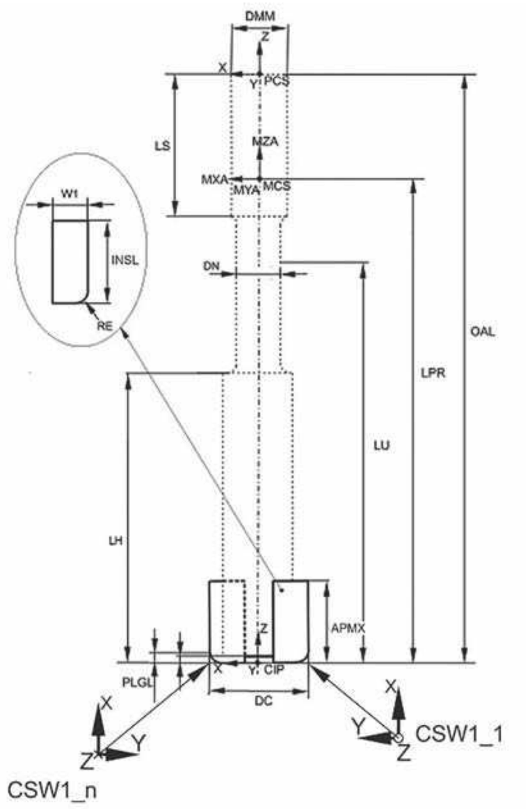

Figure 11 — Determination of CSWx_y

5.5 Chip flute and pocket seat

The chip flute shall be designed as solid body for subtraction from the tool body. The sketch of the chip flute shall be referenced to the XZ-plane of PCS and to CIP. The chip flute body shall be positioned to its final position in using the properties "GAMF", "GAMP", "KAPR" and the point "CRP" or the property "OFFCFEX" as shown in Figure 12.

The number and location of the chip flutes shall be ordered by means of using the CAD-arrangement function.

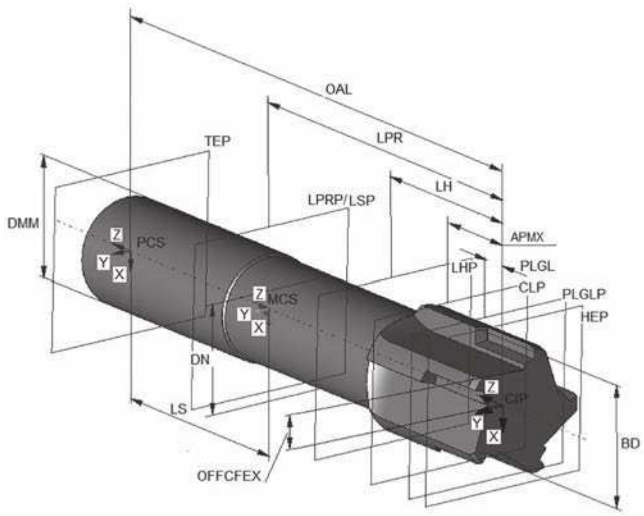

Figure 12 — Chip flute design and position

To position the pocket seat on to the body, the corresponding CSWx_y shall be selected. The pocket seat shall be designed with reference to the XY-plane of the PCS_INSERT and transformed to the corresponding CSW. Figures 13 and 14 show the relationship between CSW, CRP and MCS.

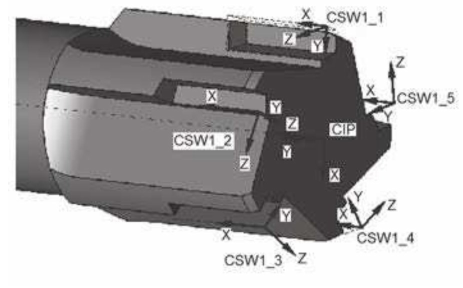

Figure 13 — Position of CSWs

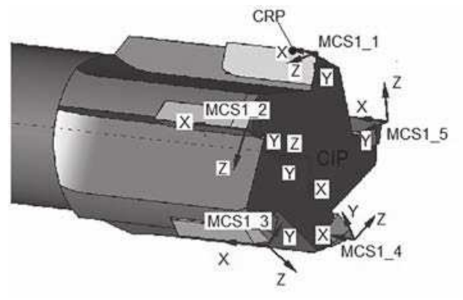

Figure 14 — Position of MCSs and CRP

5.6 Cylindrical reamer — Assembly

The assembly of the reamer shall be done by means of using the CSW's. The mounting coordinate system of the inserts MCS_INS shall be mated directly on to the corresponding coordinate system workpiece side CSWx_y. Figure 15 shows the assembled cylindrical reamer.

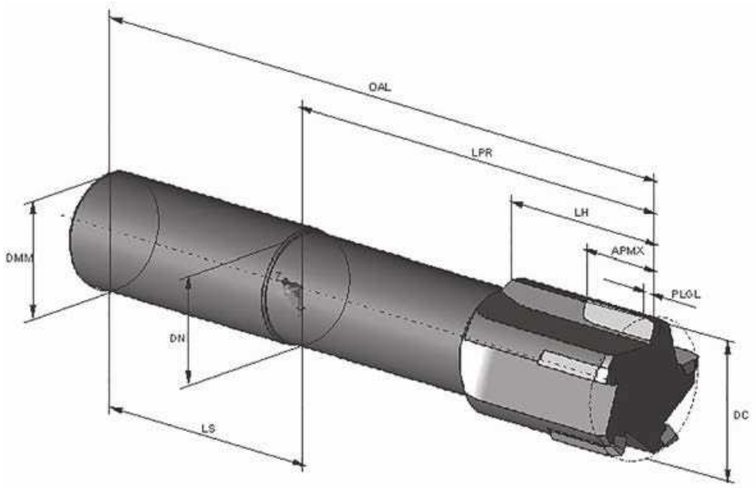

Figure 15 — Assembled cylindrical reamer

6 Tapered reamer

6.1 General

Figure 16 shows the properties to be used for the design of tapered reamers.

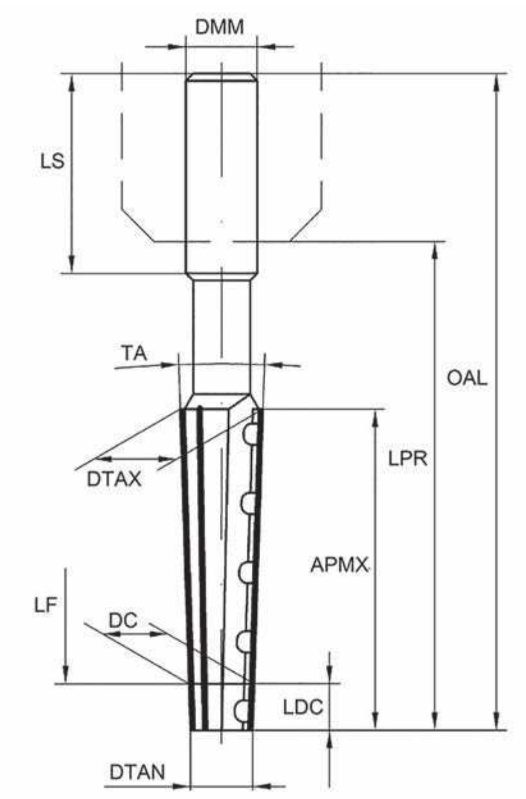

Figure 16 — Determination of properties of tapered reamers

6.2 Necessary properties

Table 4 lists the properties that are needed for the modelling of a tapered reamer.

Table 4 — Properties for the modelling of a tapered reamer

Preferred name	Preferred symbol
cutting edge length	APMX
cutting edge sequence	CESEQ
cutting diameter	DC
shank diameter	DMM
neck diameter	DN
taper diameter smallest	DTAN
taper diameter largest	DTAX
distance reference point PK	LDC
functional length	LF
protruding length	LPR
shank length	LS

Table 4 *(continued)*

Preferred name	Preferred symbol
usable length	LU
overall length	OAL
offset chip flute outer pocket	OFFCFEX
taper angle	TA

For the design of tapered reamers, either the starting diameter or the ending diameter shall be needed. Also, the distance from the starting diameter to the cutting diameter shall be necessary to determine the position of the cutting diameter along the taper.

6.3 Basic geometry

The basic of that part is a rotational design feature which contains all elements between the plane "TEP" and the plane "HEP" at the coordinate system "CIP". See Figure 17 for illustration.

The sketch includes all the elements above and shall be designed on the YZ plane of the "PCS". The rotational axis is the standard z-axis.

The design of the sketch shall be as follows.

— The sketch shall be determined as a half section.

— The sketch shall be constrained to the coordinate system "PCS" and to the planes "TEP" and "HEP" according to Figure 17. If the CAD software does not support the use of datum planes, the sketch shall be fully dimensioned; otherwise, the distances shall be in conjunction with the defined datum planes.

— The dimensioning shall be done with the appropriate properties listed in Table 4. The dimension BDX shall be calculated from the larger taper diameter.

The sketch shall be revolved about the z-axis by 360°.

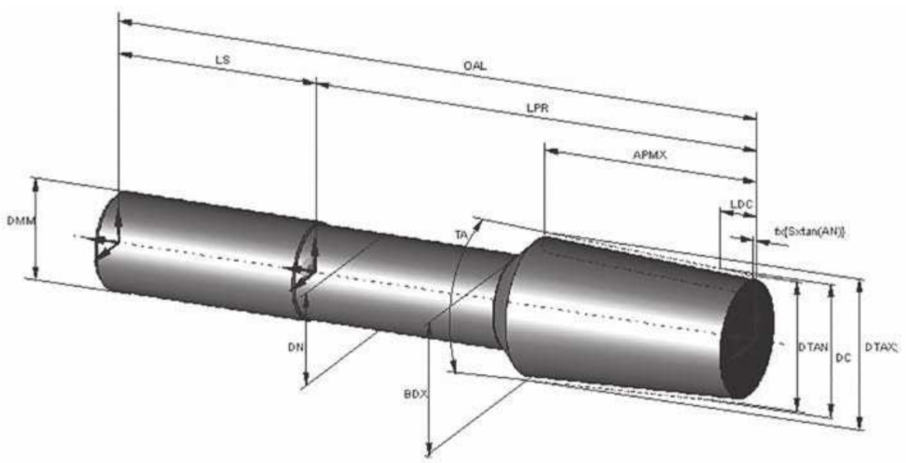

Figure 17 — Basic geometry of tapered reamer

6.4 Determination of the position of the mounting coordinate system of insert

A coordinate system workpiece side and the corresponding planes shall be determined for each insert in accordance to their definitions in ISO/TS 13399-50. See Figure 18 for the determination of CSW's.

The coordinate systems “CSWx_y” shall be referenced to “PCS”. The position is determined through the following:

— the dimensions DC, OAL;

— the geometry of the insert;

— the cutting reference point.

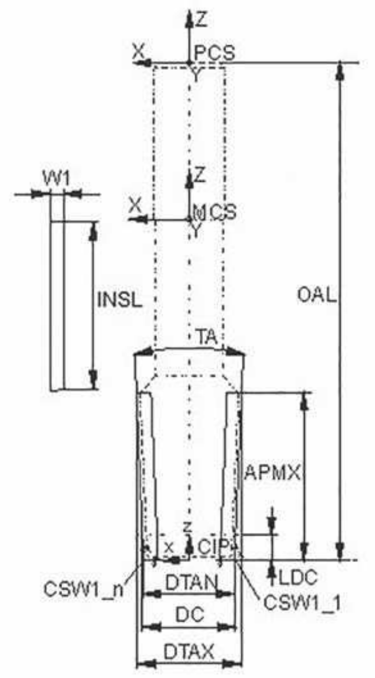

Figure 18 — Determination of CSWx_y

6.5 Chip flute and pocket seat

See 5.5 for the modelling of the chip flute and the pocket seat. The chip flute shall be designed in regards to the used insert shape and the maximum usable length. To give as much bending stiffness as possible, the chip flute shall also follow the insert contours. Figures 19 and 20 show the relationship between CSW, CRP and MCS.

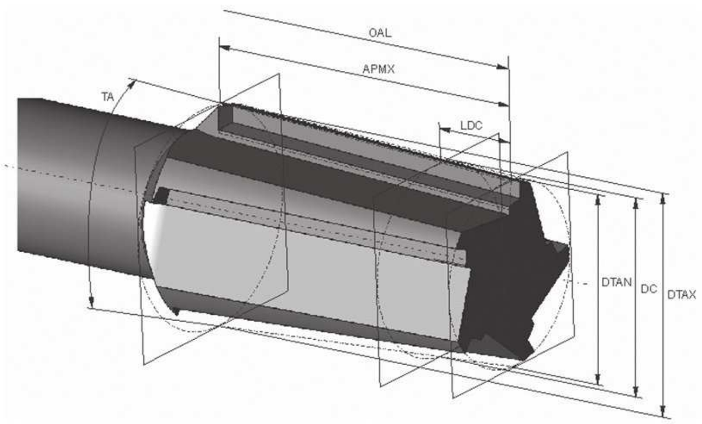

Figure 19 — Chip flute and pocket seat

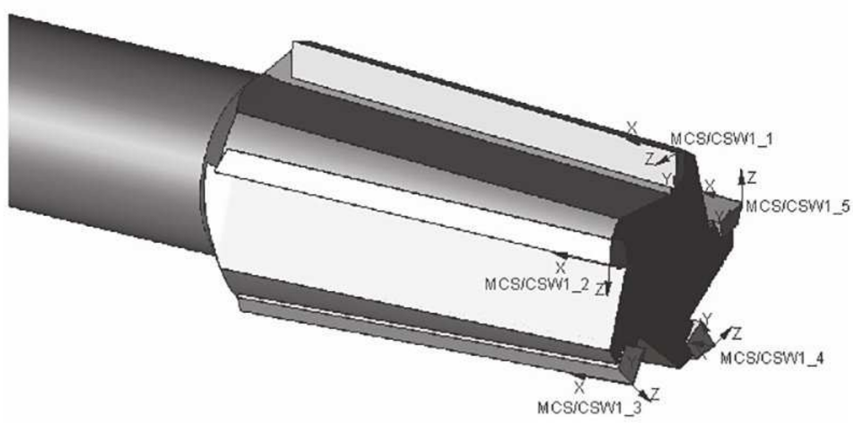

Figure 20 — Tapered reamer with mounted insert

6.6 Tapered reamer, assembled

Figure 21 shows the complete tapered reamer with inserts for reaming operations.

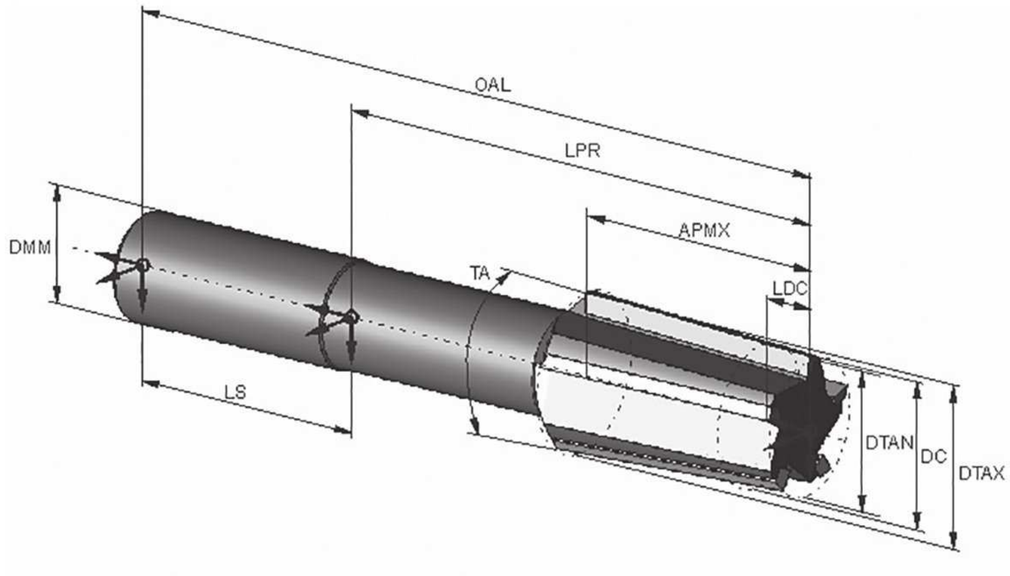

Figure 21 — Assembled tapered reamer

7 Stepped (profile) reamer

7.1 General

Figure 22 shows the properties to be used for the design of stepped reamers.

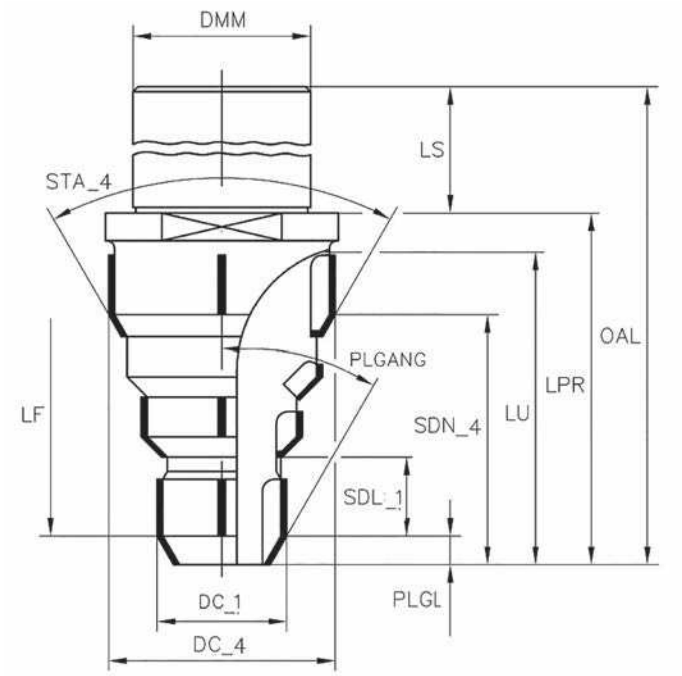

Figure 22 — Determination of properties of stepped reamers

7.2 Necessary properties

Table 5 lists the properties needed for the modelling of a stepped reamer. The example of Table 5 shows a stepped reamer with four steps.

Table 5 — Properties for the modelling of a stepped reamer

Preferred name	Preferred symbol
body diameter, first cutting step	BD_1[a]
body diameter, second cutting step	BD_2[a]
body diameter, third cutting step	BD_3[a]
body diameter, fourth cutting step	BD_4[a]
cutting edge sequence	CESEQ
cutting diameter, first cutting step	DC_1[a]
cutting diameter, second cutting step	DC_2[a]
cutting diameter, third cutting step	DC_3[a]
cutting diameter, fourth cutting step	DC_4[a]
flange diameter	DF
shank diameter	DMM
flange thickness	FLGT
functional length	LF
protruding length	LPR
shank length	LS
usable length	LU
[a] Based on the number of steps (NOS), the property is indexed by the individual step number.	

Table 5 *(continued)*

Preferred name	Preferred symbol
step count	NOS
overall length	OAL
offset chip flute outer pocket	OFFCFEX
plug length	PLGL
plug angle	PLGANG
chip flute radius	RCF
step diameter length, first cutting step	SDL_1[a]
step diameter length, second cutting step	SDL_2[a]
step diameter length, third cutting step	SDL_3[a]
step distance, second cutting step	SD_2[a]
step distance, third cutting step	SD_3[a]
step distance, fourth cutting step	SD_4[a]
step included angle, second cutting step	STA_2[a]
step included angle, third cutting step	STA_3[a]
step included angle, fourth cutting step	STA_4[a]
[a] Based on the number of steps (NOS), the property is indexed by the individual step number.	

7.3 Basic geometry

The basic of that part is a rotational design feature which contains all elements between the plane “TEP” and the plane “HEP” at the coordinate system “CIP”.

The sketch includes all the elements above and shall be designed on the YZ plane of the “PCS”. The rotational axis is the standard z-axis.

The design of the sketch shall be as follows.

— The sketch shall be determined as a half section.

— The sketch shall be constrained to the coordinate system “PCS” and to the planes “TEP” and “HEP” according to Figure 23. If the CAD software does not support the use of datum planes, the sketch shall be fully dimensioned; otherwise, the distances shall be in conjunction with the defined datum planes.

— The dimensioning shall be done with the appropriate properties listed in Table 5. The dimensions BD_x shall be calculated from the corresponding cutting diameters.

The sketch shall be revolved about the z-axis by 360°.

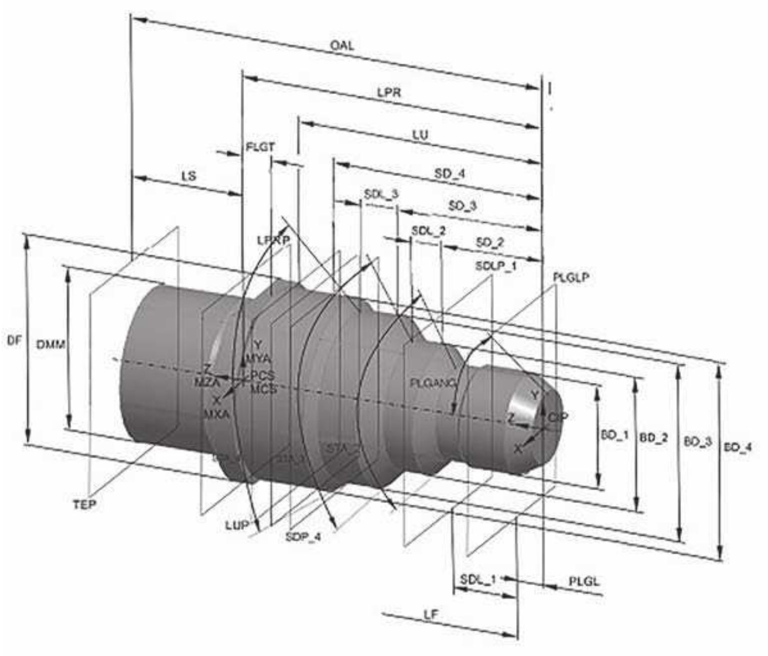

Figure 23 — Basic geometry

7.4 Determination of the position of the mounting coordinate system of insert

Coordinate systems workpiece side and the corresponding planes shall be determined for each insert in accordance to their definitions in ISO/TS 13399-50.

The coordinate systems "CSWx_y" shall be referenced to "PCS" as shown in Figure 24. The position is determined through the following:

— the dimensions OAL for the first step and then the dimension SD_x for all following steps;

— the geometry of the insert;

— the cutting reference point.

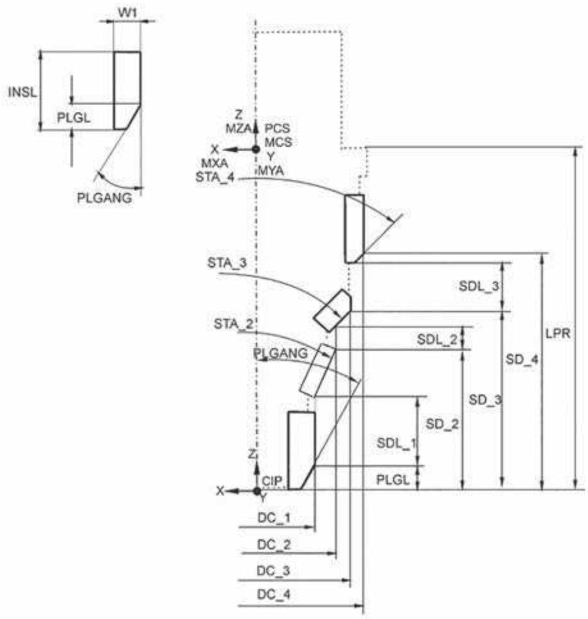

Figure 24 — Determination of CSWs and body contour on stepped reamers

The CSWs for a four-step reamer with two effective cutting edges are shown on Figure 25.

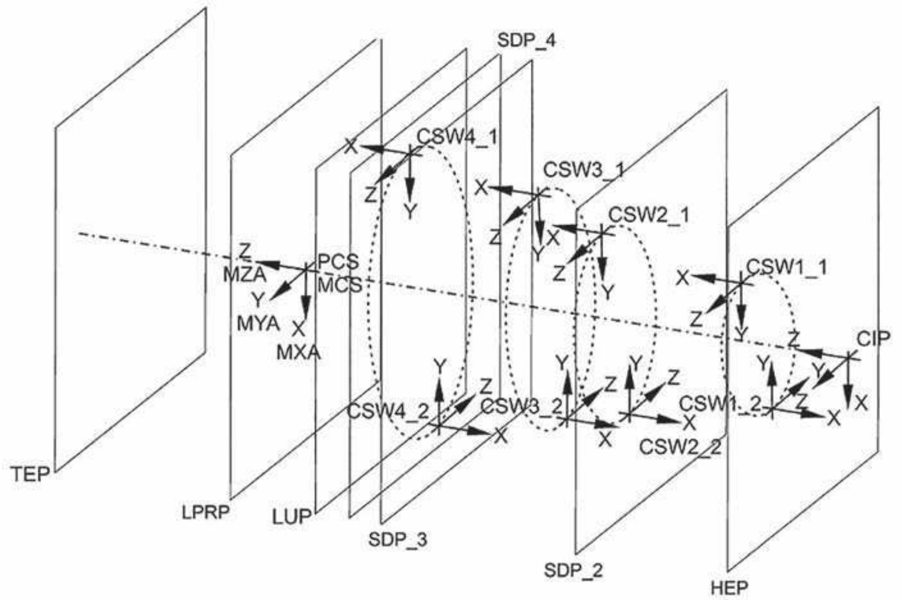

Figure 25 — Determination of coordinate systems of inserts

7.5 Chip flute and pocket seat

See 5.5 for the modelling of the chip flute and the pocket seat. The specifications of the pocket seat and its location on first step shall also be valid for the following steps as shown in Figure 26. For the position of the chip flute, the property “OFFCFEX” shall be used, which defines the distance from the tool centre line. Also, for the radius of the chip flute, the property “RCF” shall be used.

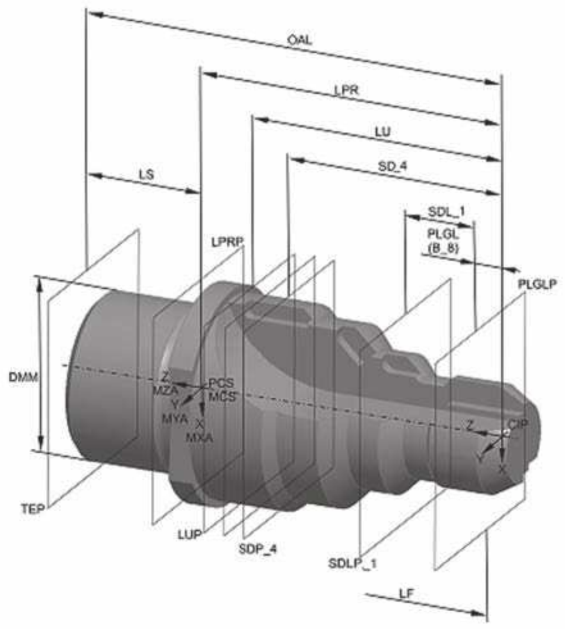

Figure 26 — Chip flute and pocket seats of a stepped reamer

For the assembly of the reaming inserts, the two defined coordinate systems “MCS” and “CSWs” shall be used. Figures 27 and 28 show the dependency of the pocket seat “CSW” and the insert “MCS”.

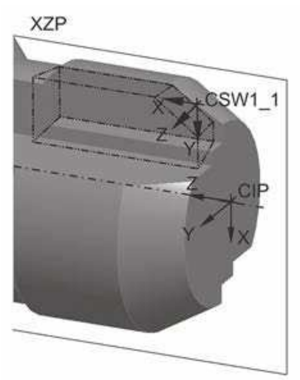

Figure 27 — Pocket seat and CSW on first step

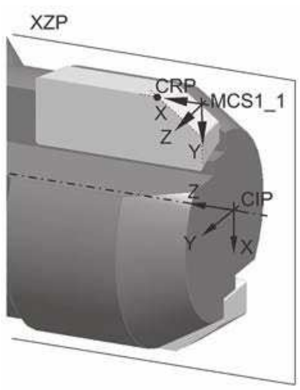

Figure 28 — Mounted reaming insert with MCS and CRP

7.6 Assembled stepped (profile) reamer

Figure 29 shows the complete stepped reamer assembled with inserts.

NOTE Figure 29 does not illustrate all the properties because of the clearness.

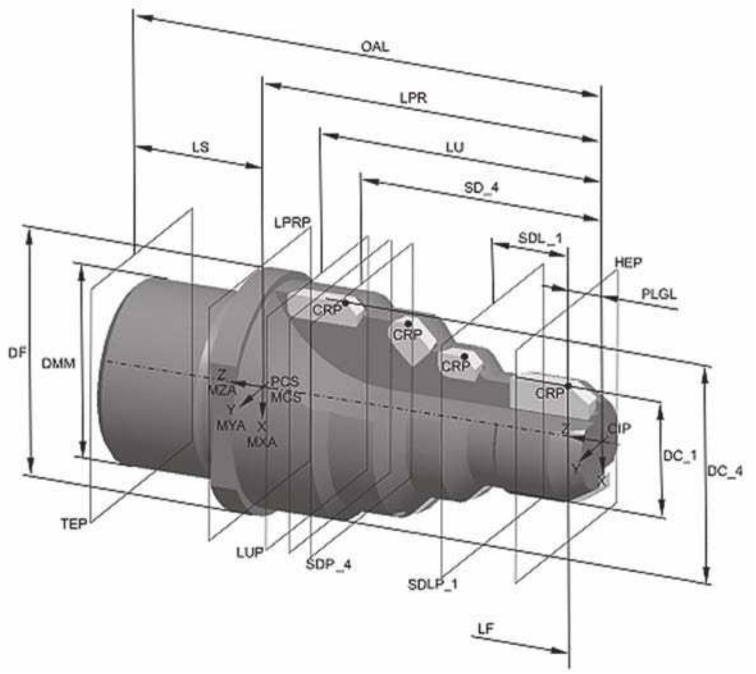

Figure 29 — Assembled stepped (profile) reamer

8 Bell style reamer

8.1 General

Figure 30 shows the properties to be used for the design of bell style reamers.

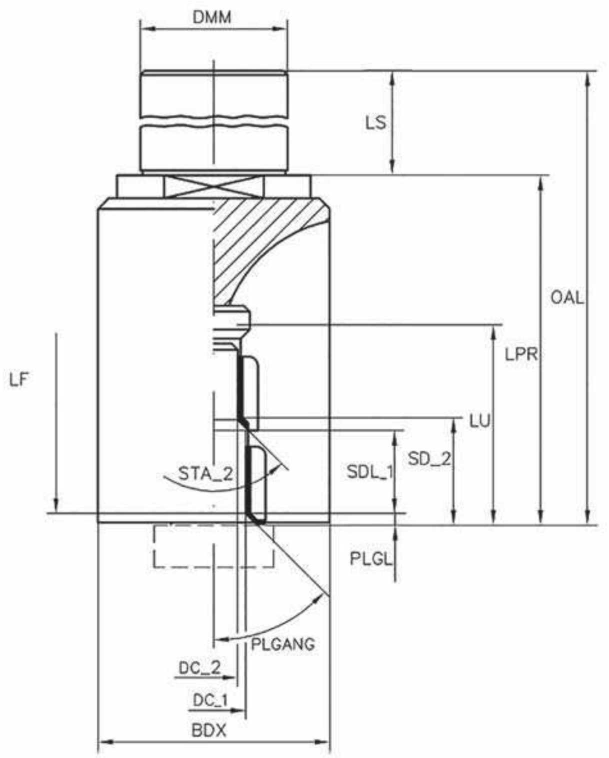

Figure 30 — Determination of properties of bell style reamers

8.2 Necessary properties

Table 6 lists the properties that are needed for the modelling of a bell style reamer. The example of Table 6 shows a bell style reamer with two steps.

Table 6 — Properties for the modelling of a bell-style reamer

Preferred name	Preferred symbol
body diameter, first cutting step	BD_1[a]
body diameter, second cutting step	BD_2[a]
body diameter, max	BDX
cutting edge sequence	CESEQ
cutting diameter, first cutting step	DC_1[a]
cutting diameter, second cutting step	DC_2[a]
flange diameter	DF
shank diameter	DMM
flange thickness	FLGT
functional length	LF
protruding length	LPR
shank length	LS
usable length	LU
step count	NOS
[a] Based on the number of steps (NOS), the property is indexed by the individual step number.	

Table 6 *(continued)*

Preferred name	Preferred symbol
overall length	OAL
offset chip flute outer pocket	OFFCFEX
plug length	PLGL
plug angle	PLGANG
chip flute radius	RCF
step diameter length, first cutting step	SDL_1[a]
step diameter length, second cutting step	SDL_2[a]
step distance, second cutting step	SD_2[a]
step included angle, second cutting step	STA_2[a]
[a] Based on the number of steps (NOS), the property is indexed by the individual step number.	

8.3 Basic geometry

The basic of that part is a rotational design feature which contains all elements between the plane "TEP" und the plane "HEP" at the coordinate system "CIP".

The sketch includes all the elements above and shall be designed on the YZ plane of the "PCS". The rotational axis is the standard z-axis.

The design of the sketch shall be as follows.

— The sketch shall be determined as a half section.

— The sketch shall be constrained to the coordinate system "PCS" and to the planes "TEP" and "HEP" according to Figure 31. If the CAD software does not support the use of datum planes, the sketch shall be fully dimensioned; otherwise, the distances shall be in conjunction with the defined datum planes.

— The dimensioning shall be done with the appropriate properties listed in Table 6. The dimensions BD_x shall be calculated from the corresponding cutting diameters.

The sketch shall be revolved about the z-axis by 360 .

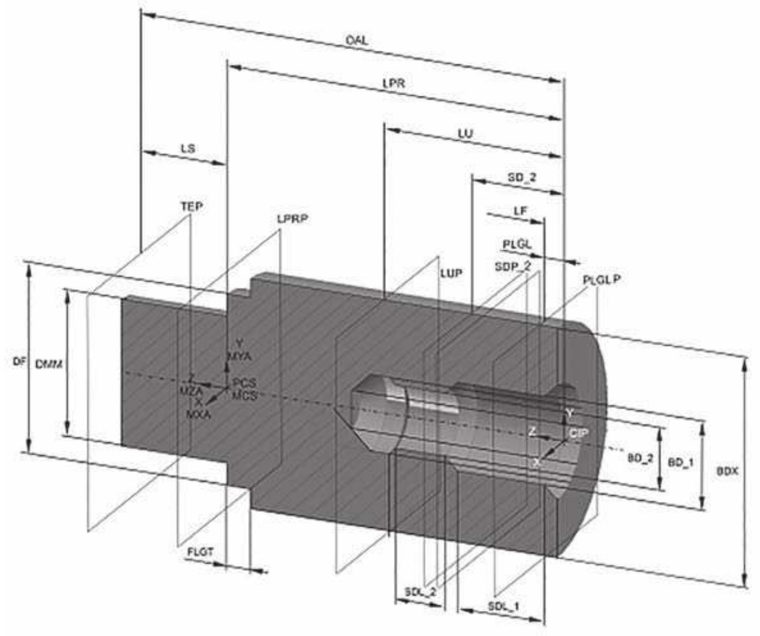

Figure 31 — Basic geometry

8.4 Determination of the position of the mounting coordinate system of insert

Coordinate systems workpiece side and the corresponding planes shall be determined for each insert in accordance to their definitions in ISO/TS 13399-50.

The coordinate systems “CSWx_y” shall be referenced to “PCS”. The position is determined through the following:

— the dimensions OAL for the first step and from that OAL the dimension SD_x for all following steps;

— the geometry of the insert;

— the cutting reference point.

See Figures 32 and 33 for the determination of the CSWs.

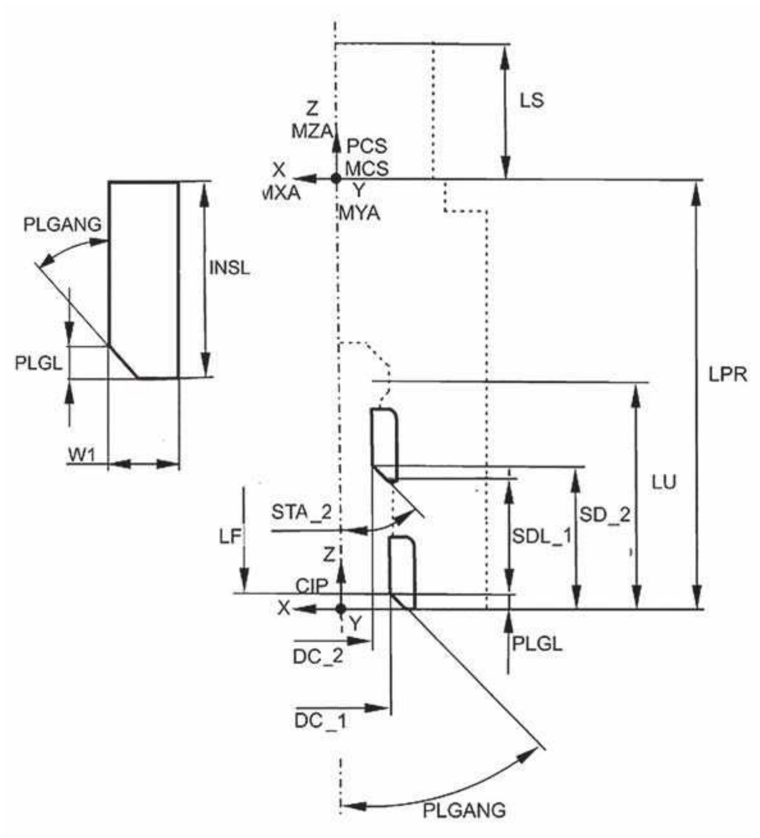

Figure 32 — Determination of CSWs and body contour on bell-style reamers

Figure 33 shows the determination and location of the CSWs for a bell-style reamer with two cutting steps.

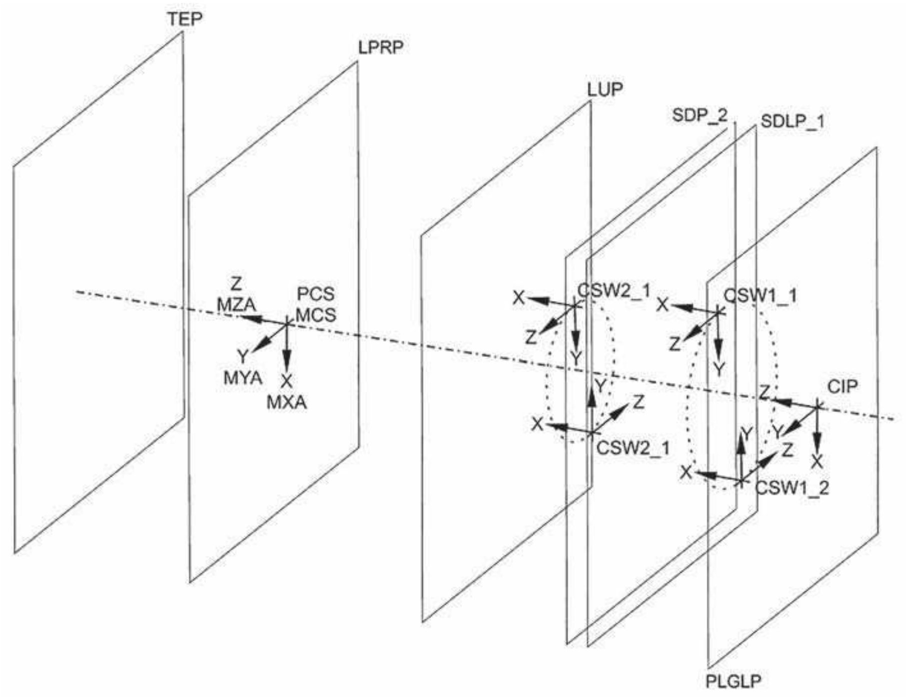

Figure 33 — Determination of coordinate systems of inserts

8.5 Chip flute and pocket seats

See 5.5 and Figure 34 for the modelling of the chip flute and the pocket seat. The specifications of the pocket seat and its location on first step shall also be valid for the following steps. For the position of the chip flute, the property "OFFCFEX" shall be used which defines the distance from the tool centre line. Also, for the radius of the chip flute the property "RCF" shall be used.

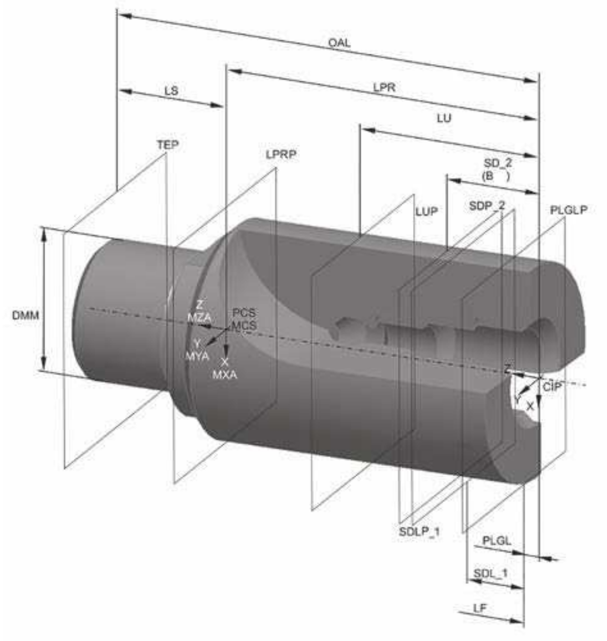

Figure 34 — Chip flute and pocket seats of a bell-style reamer

For the assembly of the reaming inserts, the two defined coordinate systems "MCS" and "CSWs" shall be used. Figures 35 and 36 show the dependency of the pocket seat "CSW" and the insert "MCS".

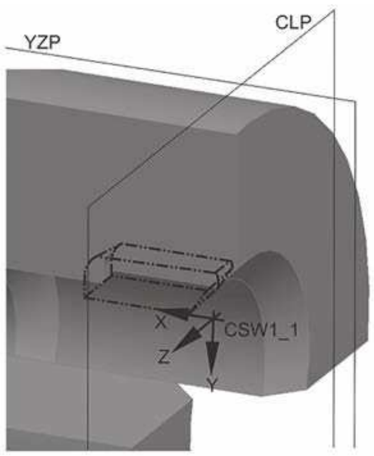

Figure 35 — Pocket seat and CSW on first step

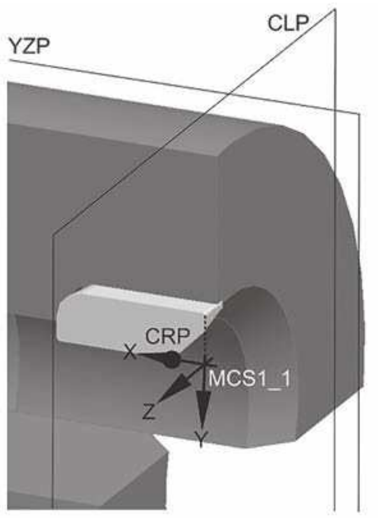

Figure 36 — Mounted reaming insert with MCS and CRP

8.6 Assembled bell style reamer

Figure 37 shows the complete stepped reamer assembled with inserts.

NOTE Figure 29 does not show all the properties because of the clearness.

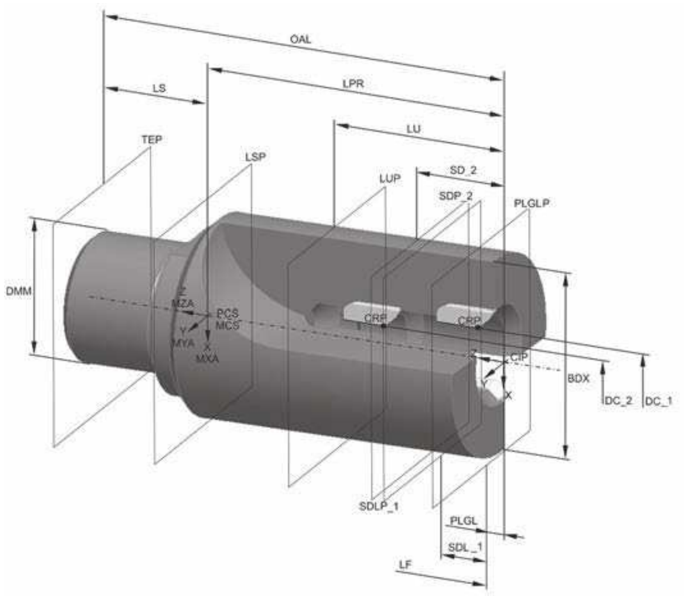

Figure 37 — Assembled bell-style reamer

9 Shell reamer

9.1 General

Figure 38 shows the properties to be used for the design of shell reamers.

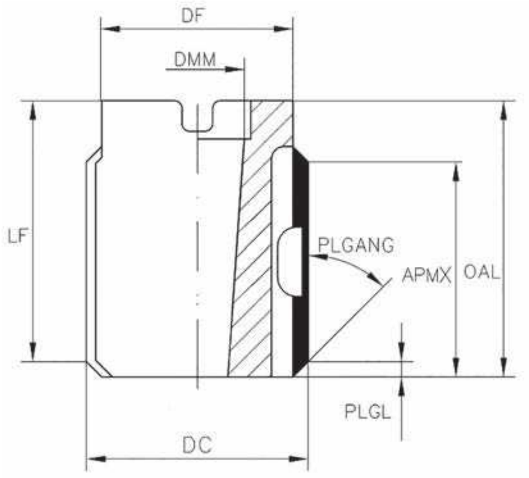

Figure 38 — Determination of properties of shell reamers

9.2 Necessary properties

Table 7 lists the properties needed for the modelling of a shell reamer.

Table 7 — Properties for the modelling of a shell reamer

Preferred name	Preferred symbol
cutting edge length, maximum	APMX
cutting edge sequence	CESEQ
cutting diameter	DC
shank diameter	DMM
flange diameter	DF
protruding length	LPR
functional length	LF
flange thickness	FLGT
head length	LH
usable length	LU
overall length	OAL
offset chip flute outer pocket	OFFCFEX
plug length	PLGL
plug angle	PLGANG
chip flute radius	RCF

9.3 Basic geometry

The basic of that part is a rotational design feature which contains all elements between the plane “TEP” and the plane “HEP” at the coordinate system “CIP”. For simplicity, the connection is designed as a simple hole without any fixing features, e.g. “drill chuck taper”.

The sketch includes all the elements above and shall be designed on the YZ plane of the “PCS”. The rotational axis is the standard z-axis.

The design of the sketch shall be as follows:

— The sketch shall be determined as a half section.

— The sketch shall be constrained to the coordinate system “PCS” and to the planes “TEP” and “HEP” according to Figure 39. If the CAD software does not support the use of datum planes, the sketch shall be fully dimensioned; otherwise, the distances shall be in conjunction with the defined datum planes.

— The dimensioning shall be done with the appropriate properties listed in Table 7.

The sketch shall be revolved about the z-axis by 360°.

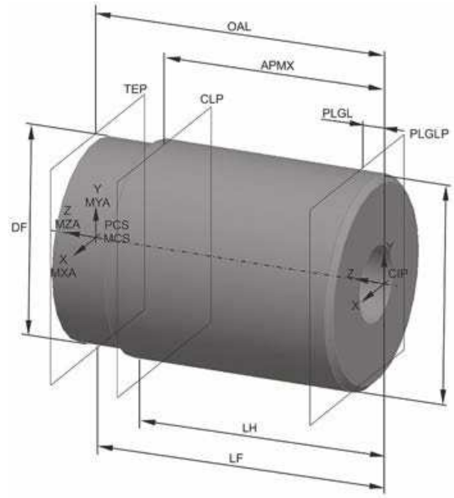

Figure 39 — Basic geometry of shell reamer

9.4 Determination of the position of the mounting coordinate system of insert

A coordinate system workpiece side and the corresponding planes shall be determined for each insert in accordance with their definitions in ISO/TS 13399-50. Figures 40 and 41 show the determination of these coordinate systems.

The coordinate systems “CSWx_y” shall be referenced to “PCS”. The position is determined through the following:

— the dimensions DC, LF;

— the geometry of the insert;

— the cutting reference point.

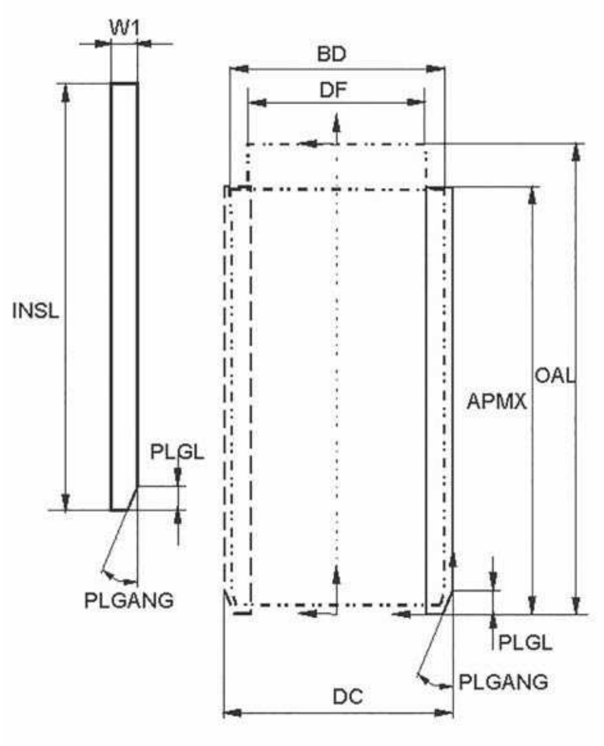

Figure 40 — Determination of CSWs and body contour on shell reamers

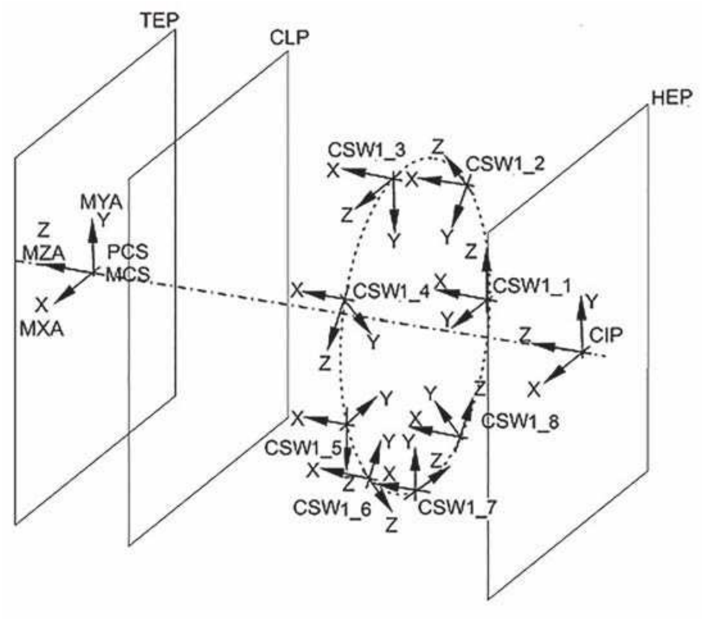

Figure 41 — Determination of coordinate systems of inserts

9.5 Chip flute and pocket seats

See 5.5 for the modelling of the chip flute and the pocket seat. For the position of the chip flute, the property "OFFCFEX" shall be used, which defines the distance from the tool centre line. Also, for the radius of the chip flute, the property "RCF" shall be used. See Figure 42 for the illustration of chip flute and pocket seat.

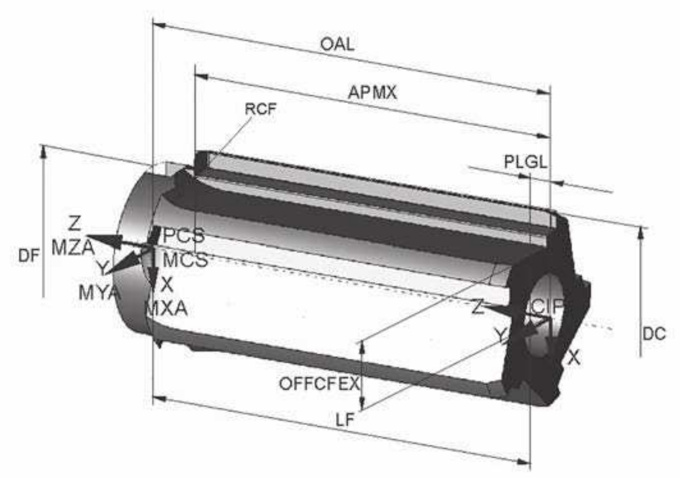

Figure 42 — Chip flute and pocket seats of a shell reamer

For the assembly of the reaming inserts, the two defined coordinate systems “MCS” and “CSWs” shall be used. Figure 43 shows the dependency of the pocket seat “CSWx_y” and the insert “MCS”.

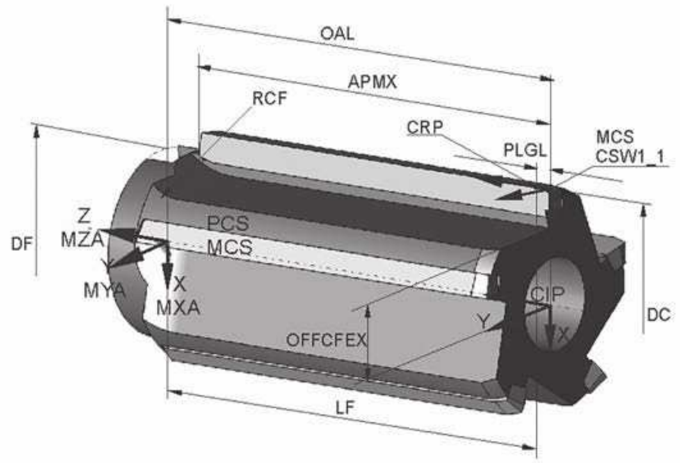

Figure 43 — Mounted reaming insert with MCS and CRP

9.6 Assembled shell reamer

Figure 44 shows the complete stepped reamer assembled with inserts.

NOTE Figure 44 does not show all the properties because of the clearness.

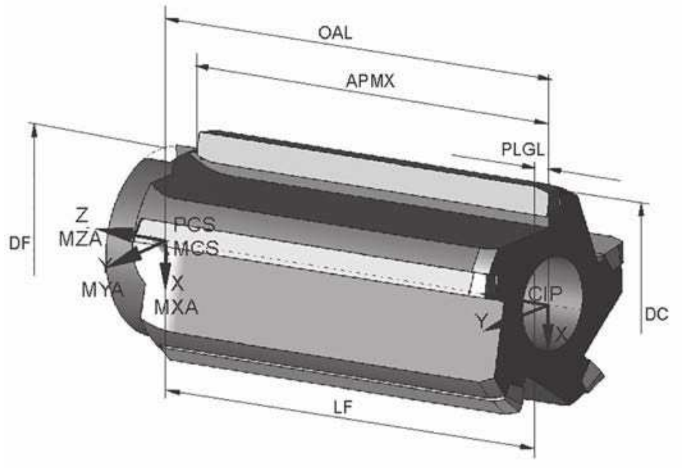

Figure 44 — Assembled shell reamer

10 Design of details

10.1 Basics for modelling

All details shall be designed as separate design features and shall not be incorporated into the revolved body of the crude geometry.

10.2 Contact/clamping surfaces — Orientation

Clamping surfaces shall be visualized within the tool model and shall be orientated by means of a unique orientation. The normal of the face shall be parallel with the "+y-axis" of the primary coordinate system "PCS" as shown in Figure 45. Drive keys shall be oriented parallel to the x-axis of the primary coordinate system "PCS" as shown in Figure 46.

Figure 45 — Orientation of planar/clamping surfaces

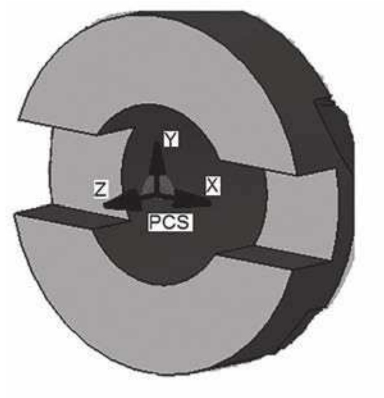

Figure 46 — Orientation of transversal driving key

10.3 Chamfers and roundings

Necessary chamfers and roundings shall be created within the according function of the 3D CAD system.

11 Attributes of surfaces — Visualization of the model features

For a printed version of this part of ISO/TS 13399, the colour settings as part of the attributes of the surfaces shall be taken in accordance with ISO/TS 13399-80.

Some CAD systems only identify one surface of the same diameter even if these surfaces are mated by means of two solid design features. Therefore, to address the surface attributes to each of these features, a revolved design feature shall be created over the cutting part feature. In the tree of elements and features, this element is called “CUTTING_SURFACE”. This design feature shall be created with the sketch elements of the cutting and non-cutting part and shall be placed at the end of the tree.

Some CAD systems give the possibility to use the available lines of the main sketches for the creation of the “CUTTING_SURFACE”. Hereby, the datum planes “CLP” and other shall be used as references. With the deletion of the main design elements, all referenced design elements shall be deleted either.

12 Structure of the design elements (tree of model)

At reaming tools for indexable inserts the insert shall be defined as cutting feature “CUT” only. The basic body of the cutting tool shall be defined as “NOCUT” design features. The design features of the basic body shall be grouped within the group “BASIC”. Hereby, it is necessary that both groups can be deleted or deactivated separately, without a mutual impact.

All the detailed design features shall be put together to a separate group named “DETAILS”. This group shall be the last element of the tree. It is dependent on the groups “CUT” and “NOCUT” and shall be deleted either, if one of these two groups shall be deleted (see Figure 47).

Such kind of grouping shall be built only if the containing design features are arranged consecutively. Therefore, care shall be taken for the correct sequence of the design features with notice to avoid reference.

The structure shall be as shown in Figure 47. It shall be similar in other CAD systems.

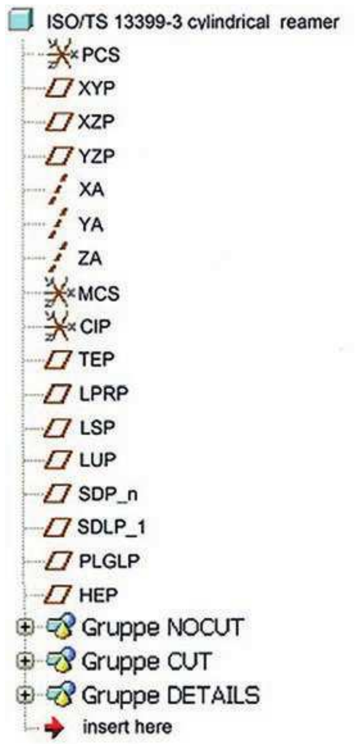

Figure 47 — Example of the structure of design features of cylindrical reamers

13 Data exchange model

The models for the data exchange are shown in examples in Figure 48 for a cylindrical reamer and in Figure 49 for a stepped reamer. All those models shall contain the geometrical features (collision contour), primary coordinate system "PCS", the mounting coordinate system "MCS" and the coordinate system in process "CIP" that are relevant for the collision examination. Also, the cutting edge line of each of the reaming inserts shall be incorporated to the model.

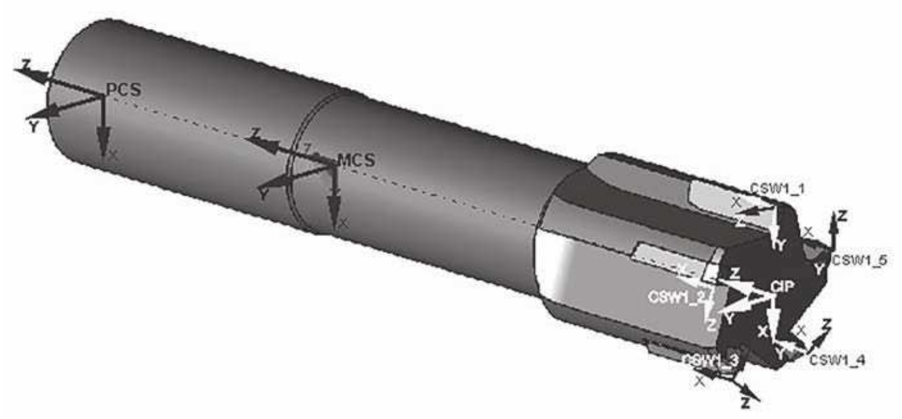

Figure 48 — Data exchange model of a cylindrical reamer

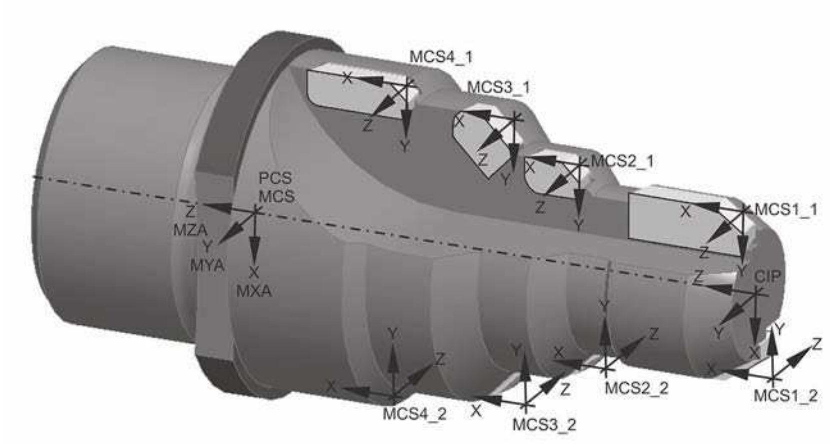

Figure 49 — Data exchange model of a stepped reamer

Annex A
(informative)

Information about nominal dimensions

A nominal dimension, a nominal size or a trade size is a size “in name only” used for identification. The nominal size may not match any dimension of the product, but within the domain of that product, the nominal size may correspond to a large number of highly standardized dimensions and tolerances. A nominal size may not even carry any unit of measure.

In measurement, a nominal value is often a value existing in name only. It is assigned as a convenient designation rather than calculated by data analysis or following usual rounding methods. The use of nominal values can be based on de facto standards or some technical standards.

All real measurements have some variation depending on the accuracy and precision of the production method and the measurement uncertainty. The use of reported values often involves engineering tolerances.

Table A.1 — Examples of nominal dimensions/sizes

Description	Value	Tolerance	Lower limit	Upper limit	Nominal dimension/size
Morse taper size 5	MT5	—	—	—	5
Internal diameter	⌀ 25	H6	25,000	25,013	25,000
External diameter	⌀ 25	g7	24,972	24,993	25,000
Square shank size h × b	32 × 25	h13	31,61 × 24,67	32 × 25	32 × 25

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