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Cutting tool data representation and exchange —

Part 314: Creation and exchange of 3D models — Cartridges for indexable inserts

Représentation et échange des données relatives aux outils coupants —

Partie 314: Création et échanges de modèles 3D — Cartouches pour plaquettes amovibles

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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 of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 29, *Small tools*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

A list of all parts in the ISO 13399 series can be found on the ISO website.

Introduction

This document defines the concept of how to design simplified 3D models of cartridges for indexable inserts 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 the ISO 13399 series 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 this document. The increasing demand providing the end user with 3D models for the purposes defined above is the basis for the development of the ISO 13399 series.

The objective of the ISO 13399 series 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, *Automation systems and integration*, SC 4 *Industrial data,* 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 *Product properties and classes and their identification*, and in its extensions defined in ISO 13584-24 and ISO 13584-25.

Cutting tool data representation and exchange —

Part 314:
Creation and exchange of 3D models — Cartridges for indexable inserts

1 Scope

This document specifies a concept for the design of tool items, limited to any kind of cartridges for indexable inserts, together with the usage of the related properties and domains of values.

This document specifies the requirements of simplified 3D models for data exchange of cartridges for indexable inserts.

The following are outside the scope of this document:

— 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 described in the scope of this document;

— concept of 3D models for adaptive items;

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

2 Normative references

The following referenced documents are indispensable for the application 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/TS 13399-50, *Cutting tool data representation and exchange — Part 50: Reference dictionary for reference systems and common concepts*

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

ISO/TS 13399-201, *Cutting tool data representation and exchange — Part 201: Creation and exchange of 3D models — Regular inserts*

3 Terms and definitions

No terms and definitions are listed in this document.

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/

4 Starting elements, coordinate systems, planes

4.1 General

The modelling of the 3D models shall be done by means of nominal dimensions. Some examples of nominal dimensions are given in Annex B. Deviations within the tolerances are allowed.

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

4.2 Reference system (PCS — Primary coordinate system)

NOTE Some of the definitions have been taken from ISO/TS 13399-50.

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

— **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 3 orthogonal planes lines respectively, named "x-axis" (XA), "y-axis" (YA) and "z-axis" (ZA).

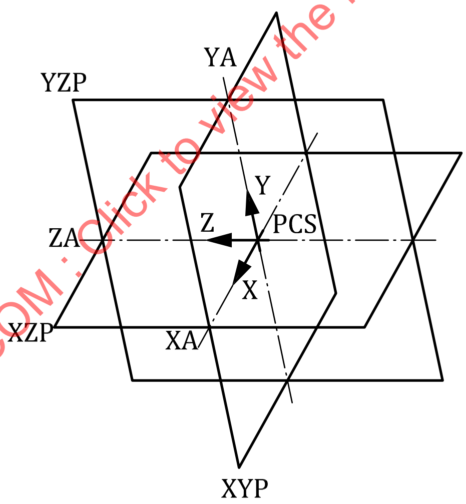

Figure 1 — Primary coordinate system

4.3 Tool item position

4.3.1 General

The definition of the tool position in 4.3.2 applies to right-handed tools. Left-hand items are as defined for right-hand items but mirrored through the YZ-plane, as specified in Annex A.

4.3.2 Prismatic tool position

A prismatic tool position identifies the location on the coordinate reference system of a turning tool with planar sides and a rectangular cross-section as illustrated in Figure 2:

— the base of the tool item shall be coplanar with the XZ-plane;

— the normal for the base of the item shall be in the -Y direction;

— the rear backing surface shall be coplanar with the YZ-plane;

— the normal for the rear backing surface shall be in the X direction;

— the end of the item shall be coplanar with the XY-plane;

— the normal for the end of the item shall be in the Z direction;

— the rake face of the primary cutting item shall be completely visible in the -X-Z quadrant;

— for cartridges, the top of the axial adjustment screw shall be coincident with XY-plane.

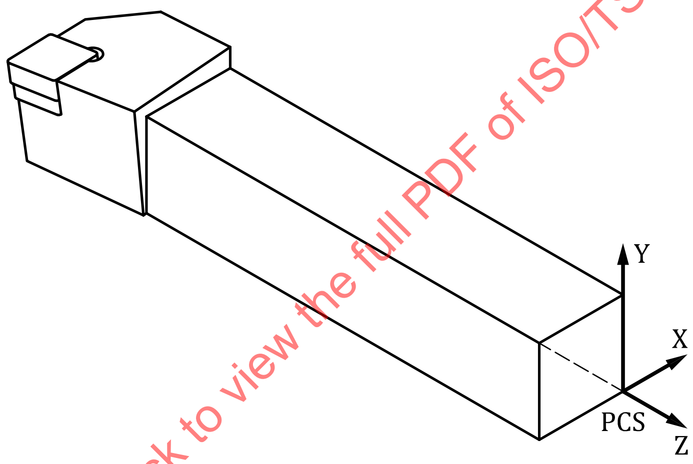

Figure 2 — Prismatic tool position

4.4 Planes

The modelling shall take place based on planes according to Figure 3, 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 cartridges for indexable inserts, the general planes shall be determined as follows:

— "CDP" — cutting depth plane: plane for the maximum cutting depth (CDX); based on "HEP";

— "HEP" — head end plane: plane for most front point of the tool; based on either LPR for tools with gauge line or contact surface or OAL for tools without gauge plane or contact surface;

— "HFP" — functional height plane: plane for the functional height (HF); based on XZ plane of PCS;

— "LSP" — shank length plane: plane for the shank length (LS); based on XY plane of PCS;

— "LFP" — functional length plane: plane for the functional length (LF); based on XY plane of PCS;

— "LHP" — head length plane: plane for the head length (LH); based on "HEP";

— "TCEP" — tool cutting edge plane: plane perpendicular to the XY plane of a master insert through its major cutting edge;

— "TEP" — tool end plane: the tool end plane is located at that end of the connection that points away from the workpiece – if the tool does not have a contact surface and/or a gauge line the TEP is coplanar with the XY-plane of the PCS. The overall length (OAL) is the distance between HEP and TEP;

— "TFP" — tool feed plane: plane perpendicular to the XZ plane that is parallel to the primary feed direction of the tool and that is tangential to the cutting corner of the master insert;

— "TRP" — tool rake plane: plane that contains the cutting edges of a master insert;

— "TSP" — theoretical sharp point: the intersection in the tool rake plane of the two planes that are perpendicular to the XY plane of the master insert through the major and minor cutting edges of the master insert;

— "WFP" — plane for the functional width (WF); based on YZ plane of PCS.

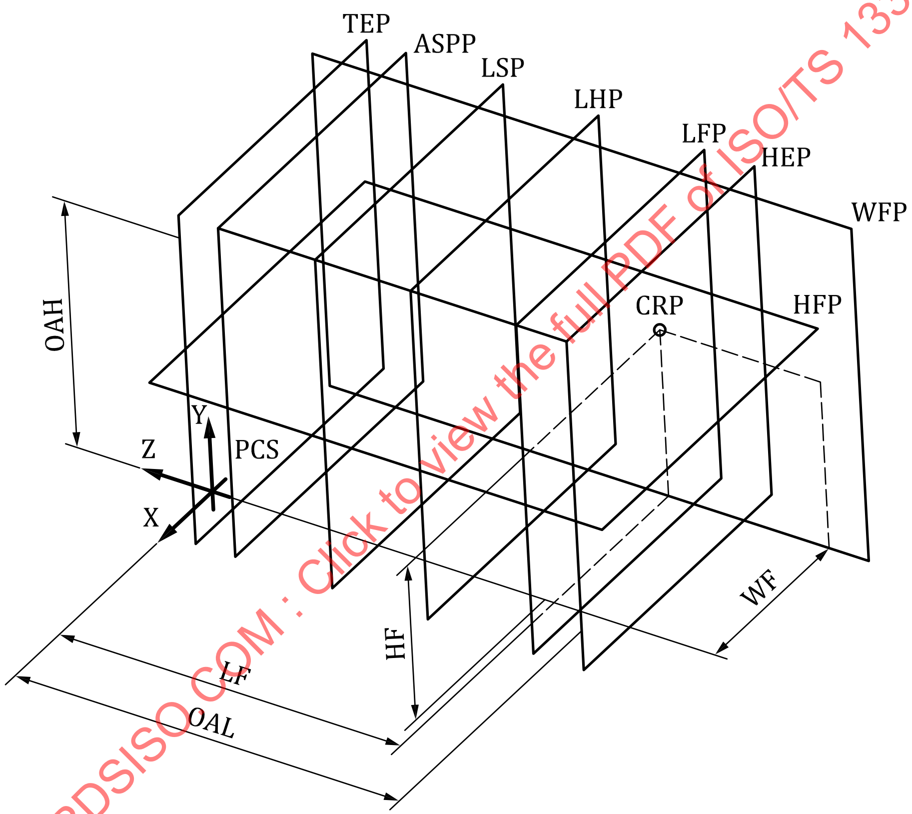

Figure 3 — Determination of the planes

4.5 Cutting reference point (CRP)

The cutting reference point is the theoretical point of the cutting tool from which the major functional dimensions are taken.

For the calculation of this point, the following cases apply.

Case 1: For a tool cutting edge angle less than or equal to 90°, the point is the intersection of **TCEP**, **TFP** and **TRP**. See Figures 4 and 5.

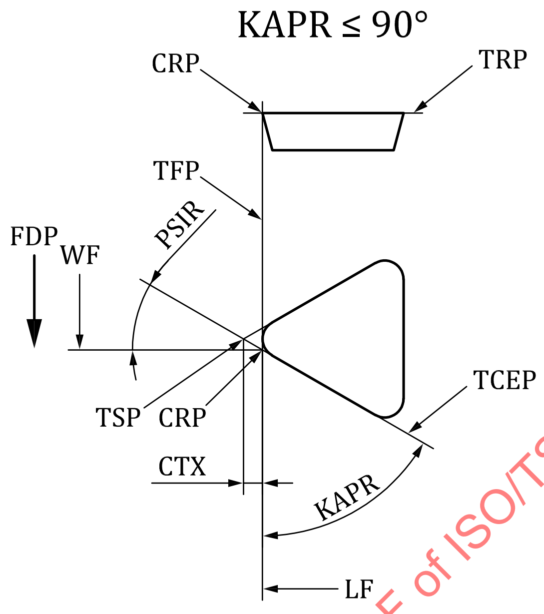

Figure 4 — Feed direction perpendicular to tool axis — KAPR ≤ 90°

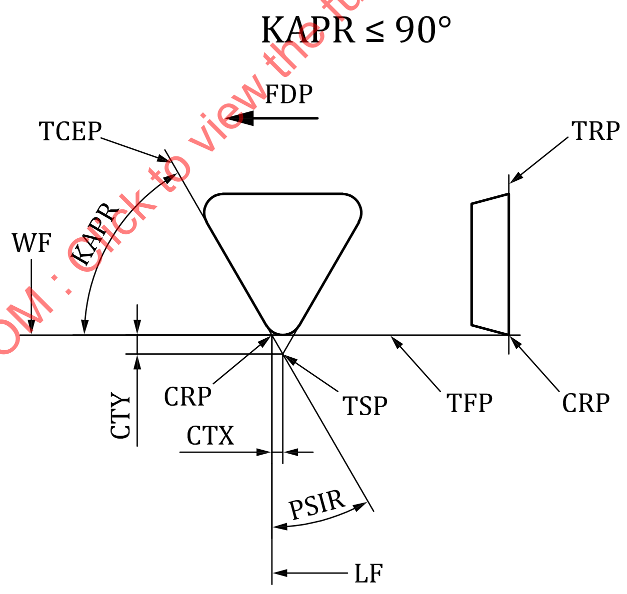

Figure 5 — Feed direction parallel to tool axis — KAPR ≤ 90°

Case 2: For a tool cutting edge angle greater than 90°, the point is the intersection of **TFP**, a plane **perpendicular to the TFP** and tangential to the cutting corner, and the **TRP**. See Figures 6 and 7.

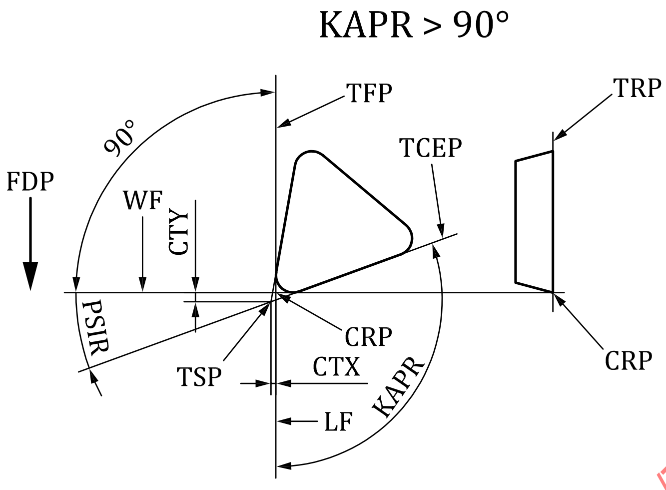

Figure 6 — Feed direction perpendicular to tool axis — KAPR > 90°

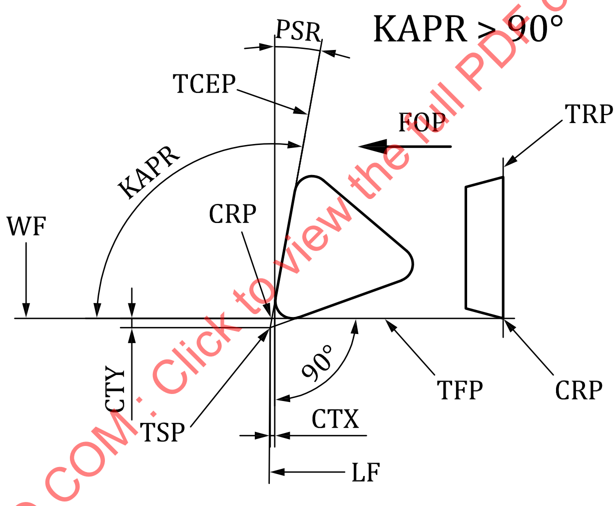

Figure 7 — Feed direction parallel to tool axis — KAPR > 90°

Case 3: For ISO tool styles D and V (ISO 5610 series) with only axial rake, the point is the intersection of a plane **perpendicular to TFP** and tangential to the cutting corner (tangential point), a plane **parallel to TFP** through the tangential point and **TRP**. See Figure 8.

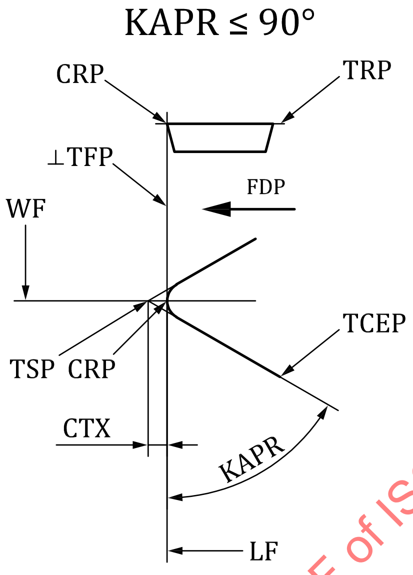

Figure 8 — CRP for neutral tools with only axial rake angle

Case 4a: For round inserts with one feed direction parallel to the tool axis, primarily used for turning tools, the point is the intersection of a plane **perpendicular to TFP** and tangential to the cutting edge (tangential point), a plane **parallel to TFP** through the tangential point, and the **TRP**. See Figure 9.

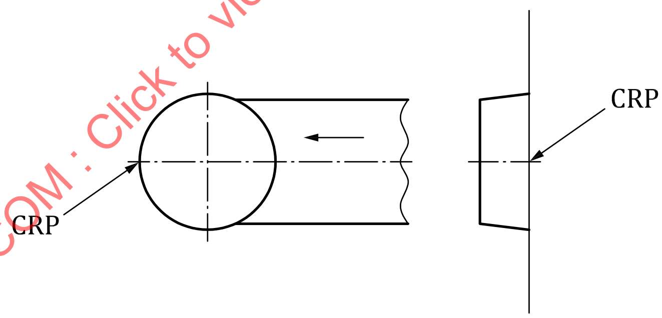

Figure 9 — CRP for round insert - TFP parallel to tool axis

Case 4b: For round inserts with two feed directions, one parallel to the tool axis and one perpendicular to the tool axis with two **CRP's**, each point is the intersection of a plane perpendicular to its feed direction and tangential to the cutting edge (tangential point), a plane parallel to the feed direction through the tangential point, and the **TRP**. See Figure 10.

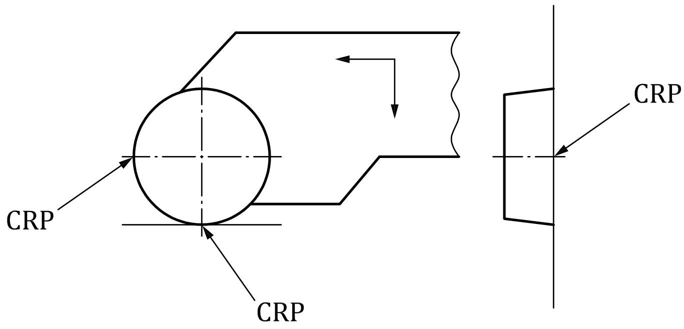

Figure 10 — Round insert with two CRP's

4.6 Adjustment coordinate system on workpiece side

4.6.1 General

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

4.6.2 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 shall start 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 shall start at the three o'clock position counting in counterclockwise 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 designates as described in Case 3. The counting shall start at the smallest diameter and at the three o'clock position counting in counterclockwise direction while looking towards the machine spindle (positive Z-axis).

An example is shown in Figure 11.

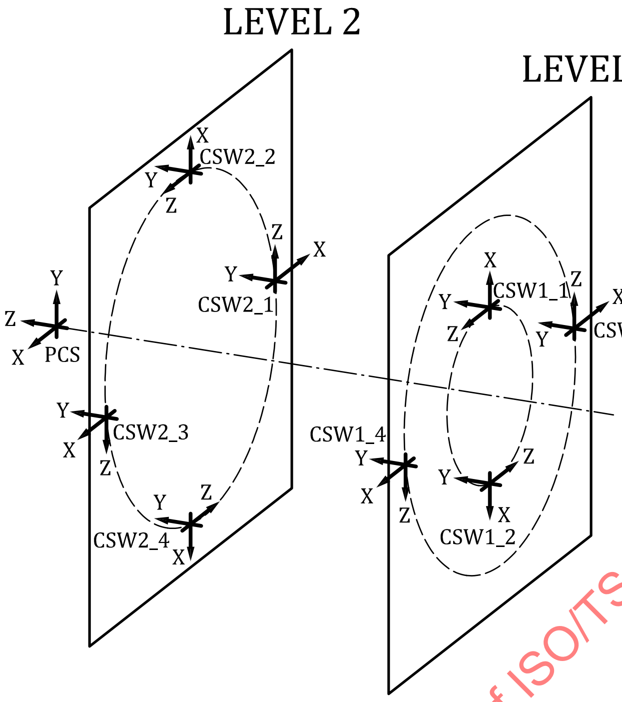

Figure 11 — Example of adjustment coordinate system on workpiece side

The MCS_INSERT shall be placed onto the CSWx_y of the tool with determinations as follows:

— The X-axis of MCS_INSERT is colinear to the X-axis of CSWx_y;

— The Y-axis of MCS_INSERT is colinear to the Y-axis of CSWx_y;

— The Z-axis of MCS_INSERT is colinear to the Z-axis of CSWx_y.

An example is shown in Figure 12.

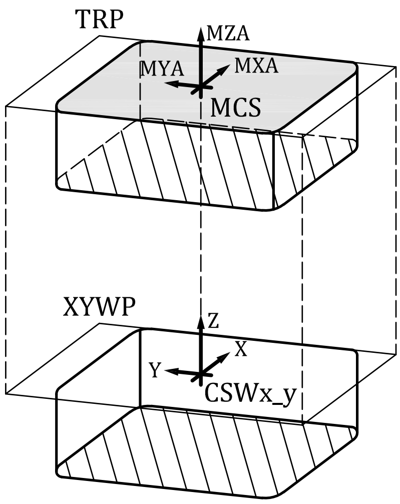

Figure 12 — Mounting of an insert on to the pocket seat

If regular inserts have a specific design and shall not be interchangeable between vendors, the location of the MCS is at 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 document.

5 Design of the model

5.1 General

The design of the model shall be according to ISO/TS 13399-80.

5.2 Necessary properties for insert and pocket seat

5.2.1 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 post fix shall be added to the preferred symbols of the cutting item properties. The postfix has the same code and sequence as the different coordinate axis systems on workpiece side.

5.2.2 Properties for equilateral, equiangular and equilateral, non-equiangular inserts

Table 1 lists the properties for equilateral, equiangular and equilateral, non-equiangular inserts.

Equilateral and equiangular inserts are:

— H — hexagonal insert;

— O — octagonal insert;

— P — pentagonal insert;

— S — square insert;

— T — triangular insert.

Equilateral and non-equiangular inserts are:

— C, D, E, M, V — rhombic insert;

— W — trigon insert.

Table 1 — Properties for modelling equilateral, equiangular and equilateral, non-equiangular pocket seats

Preferred name	Preferred symbol
clearance angle major	AN
insert included angle	EPSR
insert included angle minor	EPSRN
inscribed circle diameter	IC
cutting edge length [a]	L[a)]
corner radius	RE
corner radius minor	REN
insert thickness	S
[a] To be calculated. It is dependent on IC and EPSR.	

5.2.3 Properties for non-equilateral, equiangular and non-equilateral, non-equiangular inserts

Table 2 lists the properties for non-equilateral, equiangular and non-equilateral, non-equiangular inserts.

Non-equilateral and equiangular inserts are: L — rectangular insert.

Non-equilateral and non-equiangular inserts are: A, B, K — parallelogram-shaped insert.

Table 2 — Properties for modelling non-equilateral, equiangular and non-equilateral, non-equiangular pocket seats

Preferred name	Preferred symbol
clearance angle major	AN
clearance angle minor	ANN
insert included angle	EPSR
insert length	INSL
corner radius	RE
corner radius minor	REN
insert thickness	S
insert width	W1
cutting edge length[a]	L[a)]

[a] To be calculated. It is dependent on INSL and EPSR.

5.2.4 Properties for round inserts

Table 3 lists the properties for round inserts.

Round inserts are designated as: R — round insert.

Table 3 — Properties for modelling round pocket seats

Preferred name	Preferred symbol
clearance angle major	AN
inscribed circle diameter	IC
insert thickness	S

5.2.5 Design of the pocket seat feature

The design shall be done in accordance with ISO/TS 13399-201, but without any corner configuration on the opposite side where the functional dimensions are based.

6 ISO-cartridge, type A (ISO 5611 series)

6.1 General

Figure 13 shows the properties for the identification and classification of standardized cartridges. Additional properties shall be shown in the appropriate clause, if applicable and necessary. Figure 13 shows an example of an ISO-cartridge with side cutting edge angle.

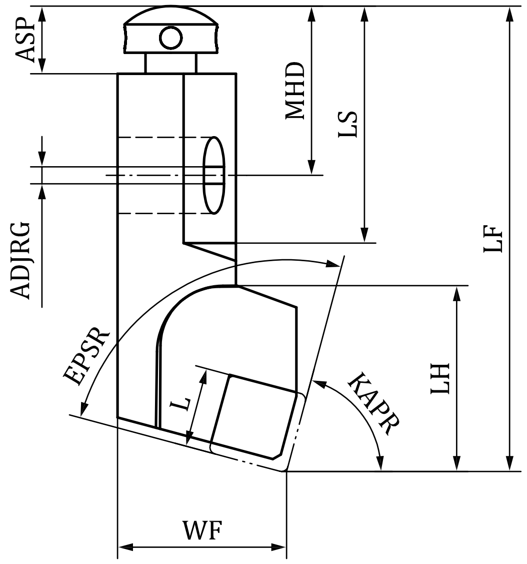

Figure 13 — Determination of properties for ISO-cartridge, type A

6.2 Necessary properties

Table 4 shows the properties needed for the modelling of ISO-cartridges, type A.

Table 4 — Properties for the modelling of an ISO-cartridge, type A

Preferred name	Preferred symbol
adjustment range	ADJRG
adjustment screw protrusion	ASP
shank width	B
cutting edge angle type code	CEATC
diameter access hole	DAH
minimum bore diameter	DMIN
included angle	EPSR
orthogonal rake angle	GAMO
shank height	H
hand	HAND
head end angle	HEA
functional height	HF
tool cutting edge angle	KAPR
cutting edge length	L
inclination angle	LAMS
functional length	LF
head length	LH
mounting hole angle	MHA
mounting hole distance	MHD
mounting hole distance 2	MHD2
mounting hole height	MHH
overall length	OAL

Table 4 *(continued)*

Preferred name	Preferred symbol
shank cross-section shape code	SX
tool holder shape code	THSC
functional width	WF

6.3 Design of the shank

For ISO-cartridges, type A, the shank is standardized with three different designs, for:

— cartridges with a functional height of 6 mm, 8 mm, 10 mm and 12 mm;

— cartridges with a functional height of 16 mm and 20 mm;

— cartridges with a functional height of 25 mm.

Figure 14 shows the properties and design of shank cross-section used for cartridges having a functional height of 6 mm, 8 mm, 10 mm and 12 mm.

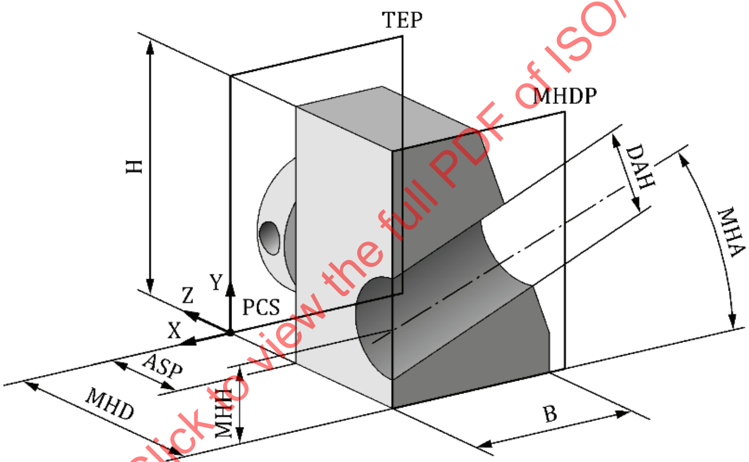

Figure 14 — Dimensions and design of the cross-section of the shank for cartridges with a functional height less than 16 mm

Figure 15 shows the properties and design of the shank applicable for cartridges having a functional height of 6 mm, 8 mm, 10 mm and 12 mm.

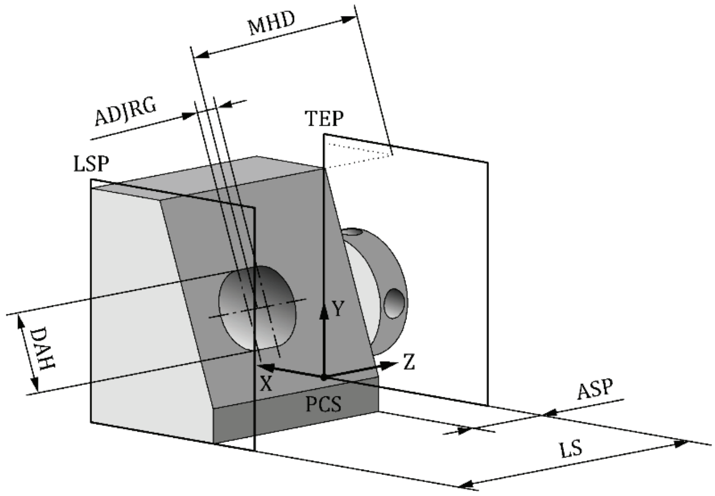

Figure 15 — Dimensions and design of the shank for cartridges with a functional height less than 16 mm

Figure 16 shows the properties and design of shank cross-section used for cartridges having a functional height of 16 mm, 20 mm and 25 mm.

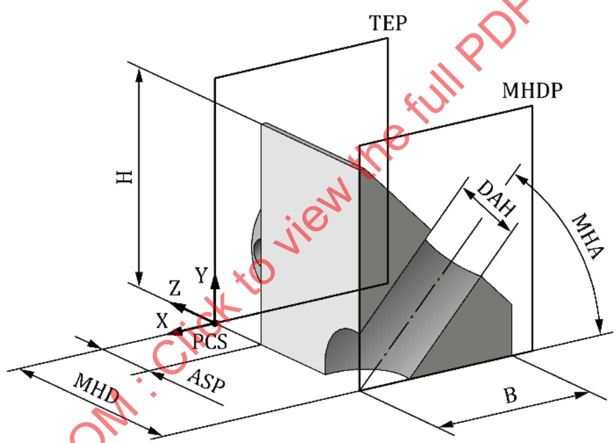

Figure 16 — Dimensions and design of the cross-section of the shank for cartridges with a functional height equal and greater than 16 mm

Figure 17 shows the properties and design of the shank applicable for cartridges having a functional height of 16 mm and 20 mm.

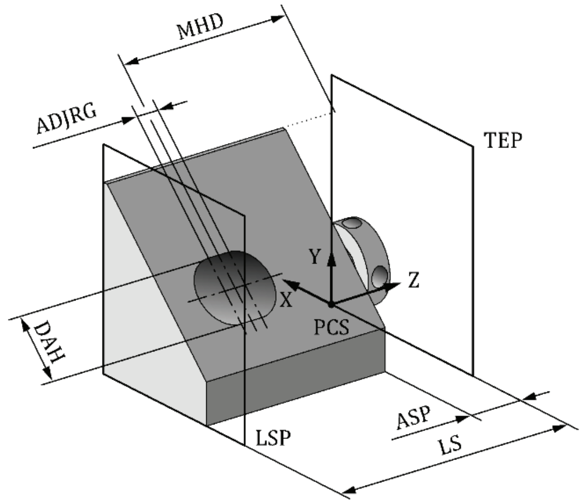

Figure 17 — Dimensions and design of the shank for cartridges with a functional height of 16 mm or 20 mm

Figure 18 shows the properties and design of the shank applicable for cartridges having a functional height of 25 mm.

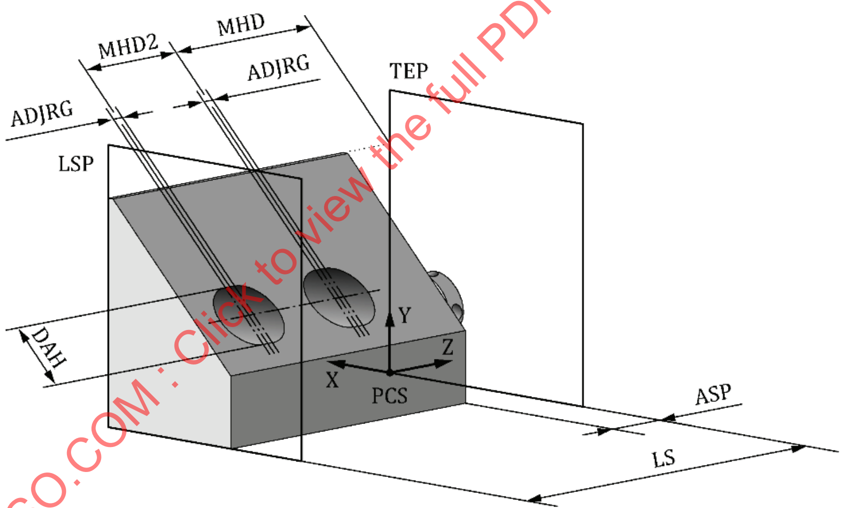

Figure 18 — Dimensions and design of the shank for cartridges with a functional height of 25 mm

For the determination of the position of the inclined clamping surface, the minimum bore diameter shall be taken into account in the calculation. The dependency between the minimum bore diameter and the clamping surface is shown in Figure 19. The position shall be determined by the dimension KN_0001.

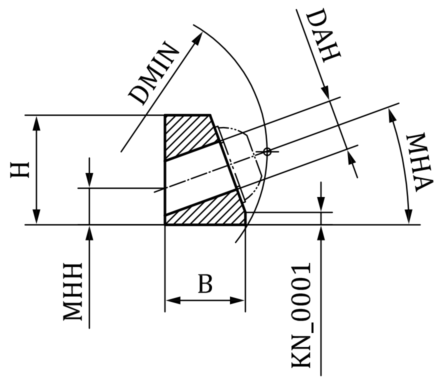

Figure 19 — Determination of position of clamping surface

Figures 14 to 19 show the design of the shank for a right-handed cartridge. For left-handed cartridges the shank shall be mirrored through the YZ plane.

6.4 Design of the basic model

6.4.1 General

The basic design of the model is a sketch (outline contour) for extrusion function which contains all elements between the plane "TEP" and the plane "HEP".

To be able to cover all the different designs specified in ISO 5608, it is recommended to name the sketches as listed in Table 5.

Table 5 — Determination of tool holder shape code for ISO-cartridges, type A

Recommended sketch designation	Tool holder shape code	Cutting edge angle type code	Insert style	Hand of tool
CA_offset_end_rhombic	offset	end cutting edge angle	rhombic	right or left
CA _offset_end_triangle	offset	end cutting edge angle	triangle	right or left
CA _offset_end_round	offset	end cutting edge angle	round	right or left
CA _offset_side_rhombic	offset	side cutting edge angle	rhombic	right or left
CA _offset_side_triangle	offset	side cutting edge angle	triangle	right or left
CA _straight_side_rhombic	offset	side cutting edge angle	rhombic	right or left
CA _straight_side_triangle	offset	side cutting edge angle	triangle	right or left

The rhombic insert style shall also include the parallelogram style of inserts (ISO code A, B, K). The triangle insert style shall also include the trigon style of insert.

The sketch includes all the real measure elements listed in Table 4 and shall be designed on the XZ plane of the PCS. The tool axis shall be the standard Z axis.

The design of the sketch shall be as follows:

— the sketch shall be determined as full section from top view (parallel to Y axis of PCS);

— the sketch shall be constrained to the coordinate system "PCS" and to the planes "TEP" and "HEP". 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 planes;

— the dimensioning shall be done with the appropriate properties listed in Table 4;

— the sketch shall be extruded along the Y axis.

Figures 20 and 21 represent an ISO-cartridge, type A, with side cutting edge angle.

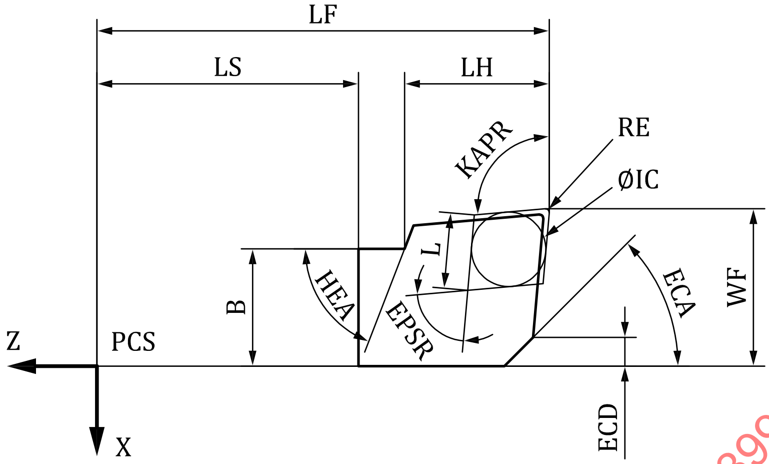

Figure 20 — Sketch of ISO-cartridge, offset, side cutting, rhombic insert

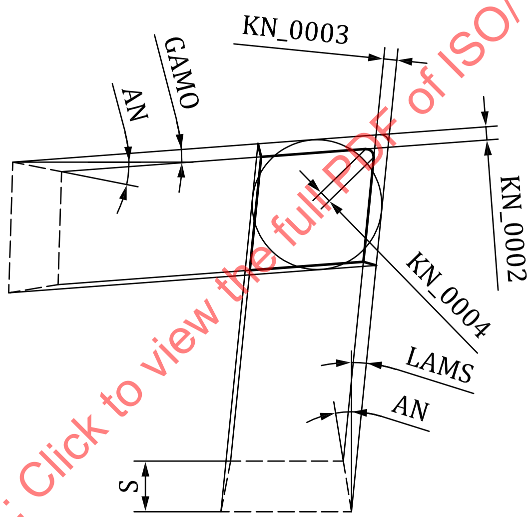

Figure 21 — ISO-cartridge, detail of pocket seat offset surfaces

The temporary dimensions KN_0002 and KN_0003 are functions of cutting edge height, normal clearance angle major cutting edge, orthogonal rake angle, normal clearance angle minor cutting edge and inclination angle; the formulas are as follows:

*KN_0002 = abs[S*tan(AN)] + abs[S*sin(GAMO)]*

*KN_0003 = abs[S*tan(AN)] + abs[S*sin(LAMS)]*

The dimension KN_0004 shall be approximately the size of the corner radius of the master insert to ensure that no collision with the workpiece occurs. It shall also be allowed to round the corner instead of chamfering as shown in Figure 21.

6.4.2 Models with "P"-clamping system for inserts

ISO-cartridges carrying an insert that is clamped with a "P"-clamping system shall have a different position of the radial adjustment screw from those cartridges having another insert clamping system. It is not shown in both cases in the 3D model. Caused by less room beyond the insert, the cartridge is modelled with a rim at the top chip surface that shall contain the radial adjustment thread. The design is shown in Figure 22.

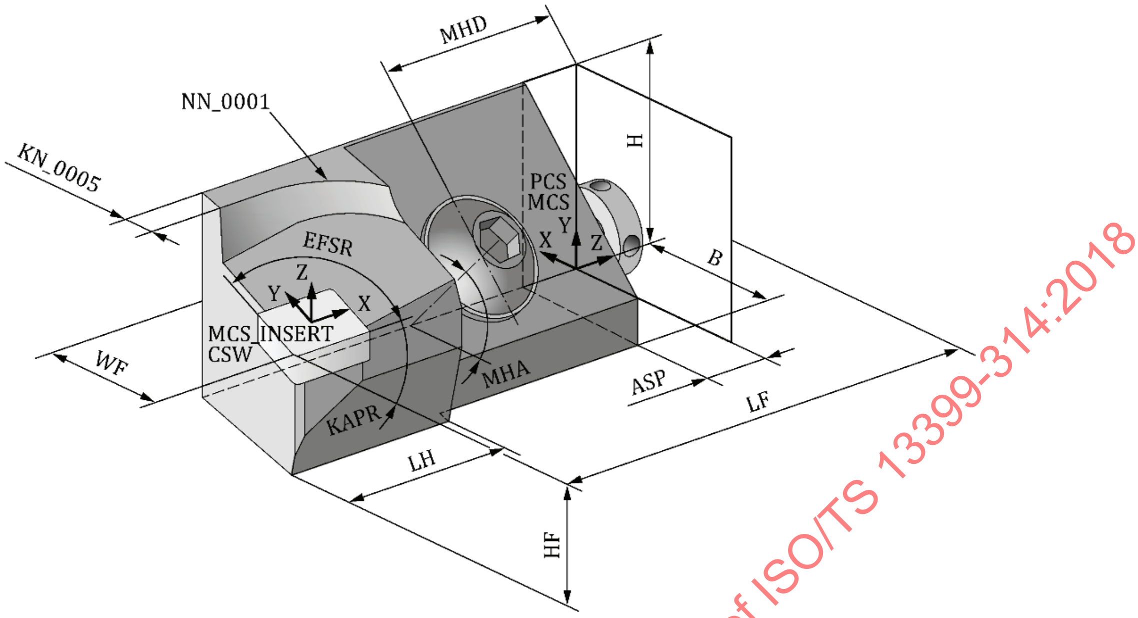

Figure 22 — Assembled side cutting ISO-cartridge with negative cutting item

6.4.3 Models with other clamping systems for inserts

ISO-cartridges carrying an insert that is clamped differently from the "P"-clamping system, and has enough room beyond the insert for a radial adjustment thread, shall be designed without a rim. This design is shown in Figure 23.

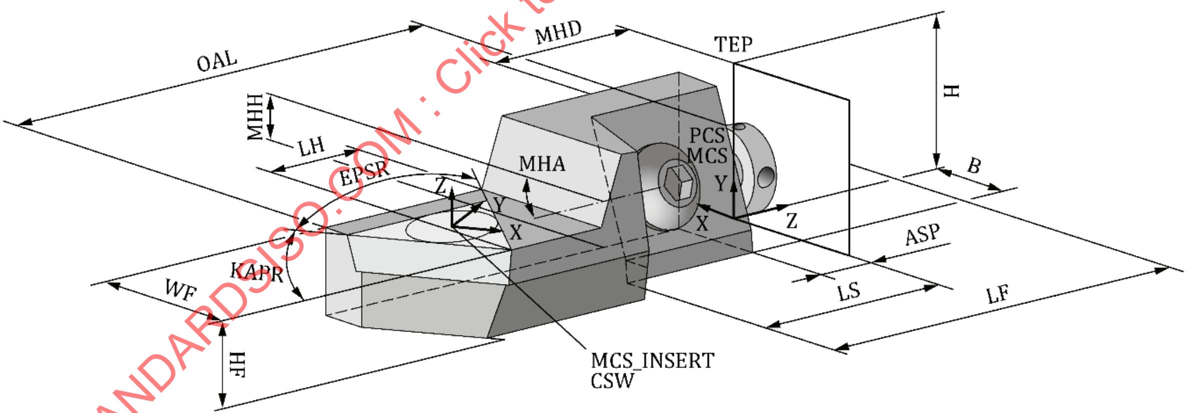

Figure 23 — Assembled end cutting ISO-cartridge with positive cutting item

7 Design of details

7.1 Basics for modelling

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