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Cutting tool data representation and exchange —

Part 80: Creation and exchange of 3D models — Overview and principles

Représentation et échange des données relatives aux outils coupants —

Partie 80: Création et échange de modèles 3D — Vue d'ensemble et principes

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Foreword

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

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

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

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

For an explanation on the 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 the following URL: www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO/TS 13399-80:2014), which has been technically revised.

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

Introduction

This document defines the concept, terms, and definitions regarding the creation and exchange of simplified 3D of cutting items, tool items, and adaptive items 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 items themselves.

Cutting tool data that can be described by the ISO 13399 series include, but are not limited to, everything between the work piece 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 this series of International Standards.

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/SC 4, 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 and in its extensions defined in ISO 13584-24 and ISO 13584-25.

Cutting tool data representation and exchange —

Part 80:
Creation and exchange of 3D models — Overview and principles

1 Scope

This document specifies the basic principles for the creation and exchange of simplified 3D models of cutting items, tool items, and adaptive items, using related properties and domains of values.

Simplified 3D models contain the following:

— naming and defining of the basic design features of cutting items, tool items, and adaptive items, with an association to the used properties;

— naming and defining of the internal structure of the 3D model that represents the features and the properties of cutting items, tool items, and adaptive items;

— naming and defining of those elements and features that are not defined in ISO/TS 13399-50, but are necessary to design 3D models.

The following are outside the scope of this document:

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

— creation and exchange of simplified 3D models for cutting tools;

— creation and exchange of simplified 3D models for tool items;

— creation and exchange of simplified 3D models for adaptive items;

— creation and exchange of simplified 3D models for assembly items and auxiliary items.

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/TS 13399-2, *Cutting tool data representation and exchange — Part 2: Reference dictionary for the cutting items*

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

ISO/TS 13399-100:2008, *Cutting tool data representation and exchange — Part 100: Definitions, principles and methods for reference dictionaries*

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 http://www.iso.org/obp

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

4 Abbreviated terms

CRP[a]	cutting reference point
CSW[a]	coordinate system workpiece side
FDP	feed direction primary
HEP	head end plane
IRPOS[a]	irregular insert position
KAP[a]	rotation angle “kappa” for the yzw-plane counter clockwise about the y-axis
LCFP	chip flute length plane
LPRP	protruding length plane
LSP	shank length plane
LUP	usable length plane
MINST[a]	master insert
MPLANE[a]	mirror plane
PAIP[a]	prismatic adaptive item position
PCS[a]	primary coordinate system
PHI[a]	rotation angle “phi” for the xzw-plane counter clockwise about the z-axis
PTIPOS[a]	prismatic tool item position
REFSYS[a]	reference system
RHO[a]	rotation angle “rho” for the xyw-plane counter clockwise about the x-axis
RIPOS[a]	regular insert position
TCEP[a]	tool cutting edge plane
TEP	tool end plane
TFP[a]	tool feed plane
TRP[a]	tool rake plane
TSP[a]	theoretical sharp point
XYP[a]	xy-plane
XYWD[a]	xyw plane distance
XYWP[a]	xyw-plane

XZP[a] xz-plane

XZWD[a] xzw plane distance

XZWP[a] xzw-plane

YZP[a] yz-plane

YZWD[a] yzw plane distance

YZWP[a] yzw-plane

[a] Taken from ISO/TS 13399-50.

5 Designation of design elements

5.1 General

The creation of 3D models shall be by means of nominal dimensions.

NOTE Some of the designations are taken from ISO/TS 13399-50.

All designations of 3D design elements (coordinate systems, planes, axes, points, solid design elements) shall be based on the designations and preferred symbols of ISO/TS 13399-2 and ISO/TS 13399-60.

If additional properties are required, they shall be requested through the ISO 13399 Maintenance agency as defined in ISO/TS 13399-100:2008, Annex D.

5.2 Reference system

5.2.1 Primary coordinate system "PCS"

The primary coordinate system, as shown in Figure 1, shall consist of the following standard elements:

— right-handed rectangular Cartesian system in three-dimensional space with three principal axes labelled X, Y, and Z;

— three orthogonal planes built from the three principal axes and named "XYP", "XZP", and "YZP";

— three orthogonal axes built from the planes and named "XA", "YA", and "ZA".

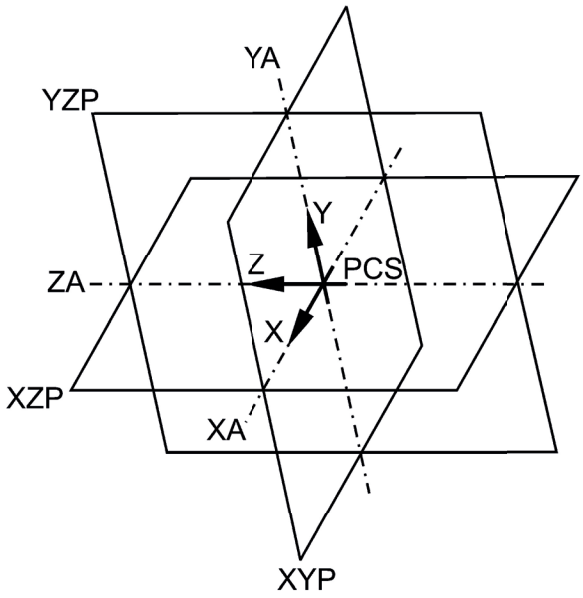


Figure 1 — Primary coordinate system "PCS"

5.2.2 Coordinate system workpiece side "CSW"

5.2.2.1 General

A single coordinate system at the workpiece side is named "coordinate system workpiece side" (CSW) and is used for the mounting of cutting tool components to build a complete cutting tool. If more than one CSW is used to assemble a complete cutting tool, the CSWs shall be indexed.

CSW is a right-handed rectangular Cartesian system in three-dimensional space with three principal axes labelled "XW", "YW", and "ZW". Figure 2 shows an example of CSW orientation.

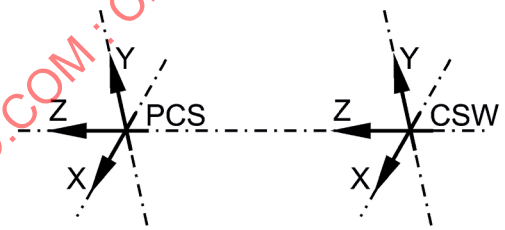


Figure 2 — Example of CSW orientation

5.2.2.2 Case 1: One coordinate system at the workpiece side

A single coordinate system at the workpiece side shall be designated "CSW".

5.2.2.3 Case 2: One coordinate system at workpiece side on different levels

A single coordinate system on different levels shall be designated "CSWn", 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. On a stepped tool, the CSW closest to the workpiece shall be on level 1, the CSW on the next stepped diameter shall be on the next level.

5.2.2.4 Case 3: Multiple coordinate systems at one level and different angles

Multiple coordinate systems at one level, but different angles and not at the centre of the tool axis shall be designated "CSWn_m", where the "n" defines the level and the "m" 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).

5.2.2.5 Case 4: Multiple coordinate systems at one level, one angle and different diameters

The designation is the same as described in case 3. The counting starts at the smallest diameter.

5.2.2.6 Case 5: Multiple coordinate systems at multiple levels, different angles and different diameters

The designation is the same as described in case 3. The counting starts 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).

All cases defined above are applicable to tool items, adaptive items, and cutting tools.

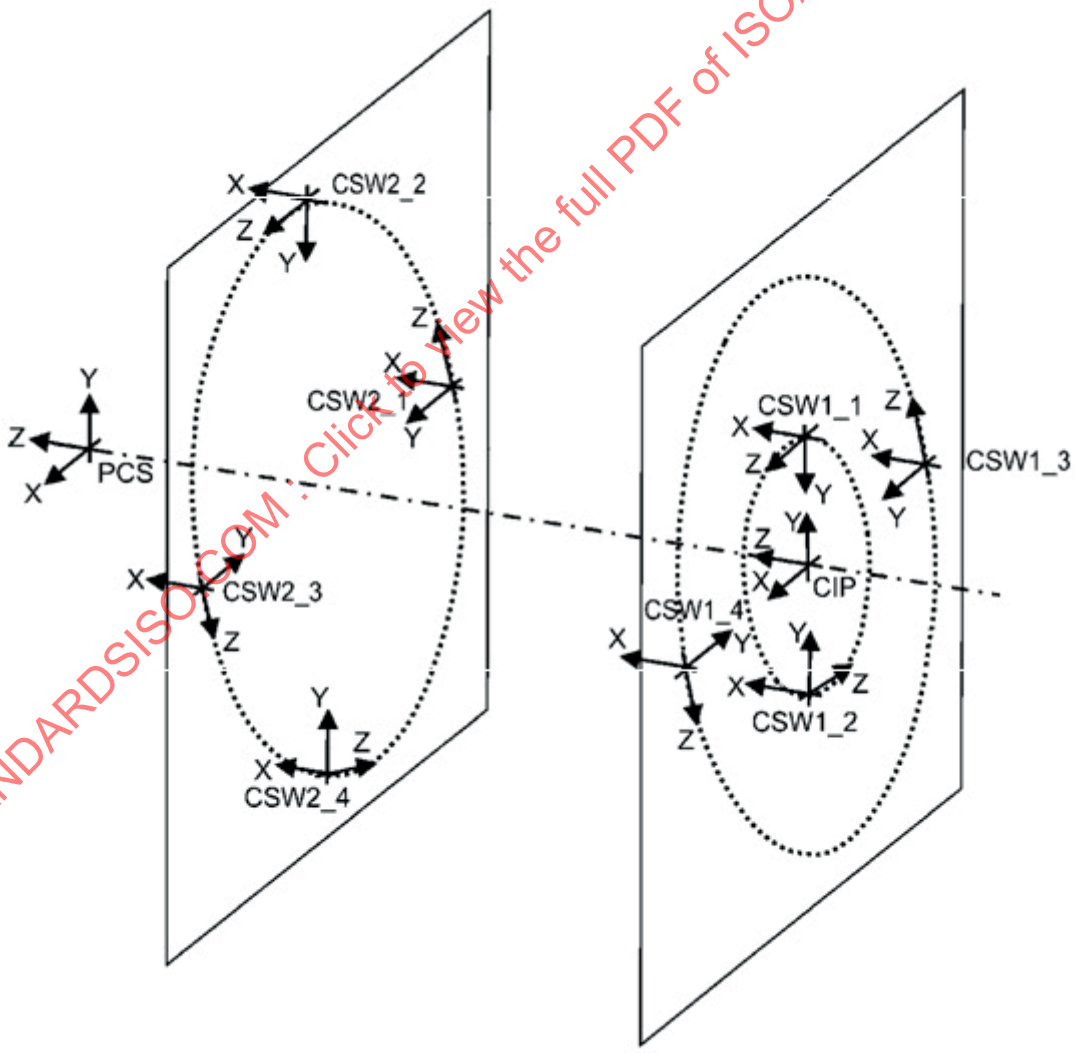


Figure 3 — Adjustment coordinate system on workpiece side

5.3 Planes

5.3.1 Primary planes

See 5.2.1.

5.3.2 Planes at workpiece side

For each existing “CSW”, the three planes shall be built from the principal axes and named “XYWP”, “XZWP”, or “YZWP”. If more than one CSW is on the item model, they shall be indexed as defined in 5.2.2.

5.4 Axes

5.4.1 Primary axes

See 5.2.1.

5.4.2 Axes at workpiece side

For each existing “CSW”, the three planes shall be built from the principal axes and named as “XWA”, “YWA”, or “ZWA”. If more than one CSW is on the item model, they shall be indexed as defined in 5.2.2.

5.5 Solid design elements

Solid design elements like profiles, revolved bodies, extruded bodies, and so on, as well as their sketches, shall have descriptive and useful names, e.g. for the pocket seat of an insert: “POCKET_SEAT_FEATURE”.

5.6 Level of detail

5.6.1 General

Simplified models shall be differentiated by the level of detail:

— basic model (see 5.6.2);

— detail model (see 5.6.3).

Copyright is reserved for the Copyright holder for proprietary information included in the Model.

Model purposes:

a) Basic model: model is used by receiving applications for NC simulation and collision detection.

b) Detail model:

   1) model is used by receiving applications to create tool or “tool assembly” drawings;

   2) model is used by receiving applications to create a basic model;

   3) model is used by receiving applications for other documentation purposes;

   4) model can also be used for collision detection (for example, during non-cutting movement with stopped spindle).

Defined use cases impact different levels of detail. A production model is not covered by this document because of the impact on data exchange and other processes.

5.6.2 Basic model

The basic geometry shall be unambiguous, but not necessarily accurate to reality. The shell of the geometry shall be shown to scale, as well as any detail being used for functionality and identification. No relevant features for unambiguous depiction and/or function can be omitted.

If features located at the periphery shall be simplified, then the maximum dimensions shall be taken for the design of these features. Examinations of collision are possible unconfined in regards of these features.

The design of internal features is at the designer's discretion as long as it is unimportant for the function.

The maximum space of extension shall be enclosed. Features like chamfers, rounding, slots, threads, chip flutes, and internal contours can be omitted as long as they are not relevant for unambiguous depiction.

The basic geometry can be used for the planning of products, operating devices, and equipment. The main focus is on a small data file volume and the characteristic geometrical properties as used for NC-programming and simulation processes.

5.6.3 Detailed model

The detailed geometry shall be accurate enough to fulfil its purpose (see 5.6.1). The vendor is entitled to remove any proprietary geometry.

6 Colour setting

6.1 Colour setting for the model

3D model shall have colour settings as follows:

— geometry of the cutting part: light grey with 80 % white [RGB (red green blue): 204/204/204];

— geometry of the shank (interface to machine) and the non-cutting part: grey with 50 % white (RGB: 128/128/128);

— geometry of spare parts (if desired to visualize): dark grey with 30 % white (RGB: 77/77/77).

6.2 Colour setting for the cutting edge line and the cutting part line

The aim of this document is to provide 3D models for end-to-end use in the NC process chain including the simulation processes. To ensure this, it is important to add a feature as follows:

— models of replaceable inserts shall contain a closed curve, named "cutting edge line", along the simplified cutting edges;

— models of cutting tools with non-indexable cutting edges shall contain either a closed or an open curve, named "cutting part line" (this curve can be created by means of using the virtual "cross-section" along the tool axis applying on the cutting part).

In both cases, the result shall be a simplified curve, which represents the simplified 3D geometry.

This curve shall be visualized in the model in a blue colour (RGB: 0/0/255); in printed versions of the standards of this document, it shall be visualized in black. The curve shall be grouped to the "CUT" part.

If a CAD-system does not allow the colours to be set as described above, the setting should have a deviation of ±1 % of the given RGB values, which shall be interpreted as follows:

— cutting part: 79 % to 81 % white;

— non-cutting part: 49 % to 51 % white;

— spare part: 29 % to 31 % white.

The RGB values shall be calculated accordingly.

6.3 Colour setting overview

See Figure 4.

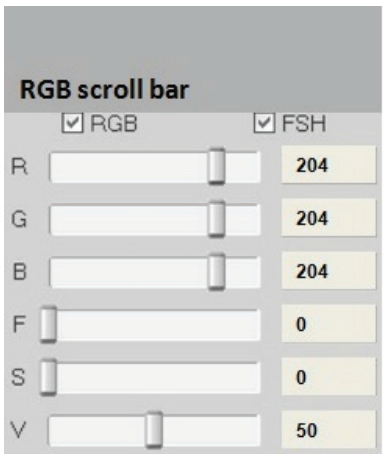
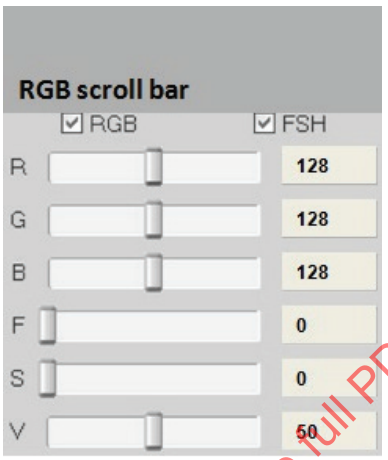
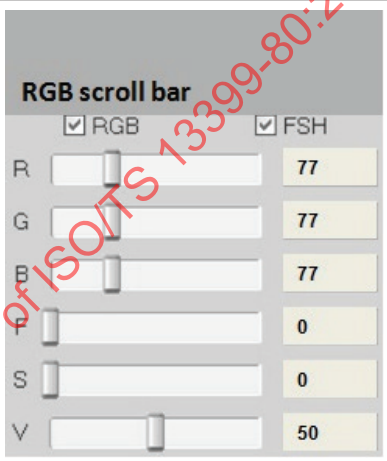
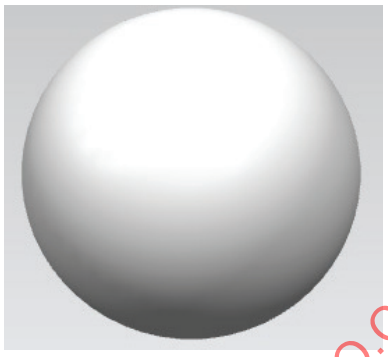
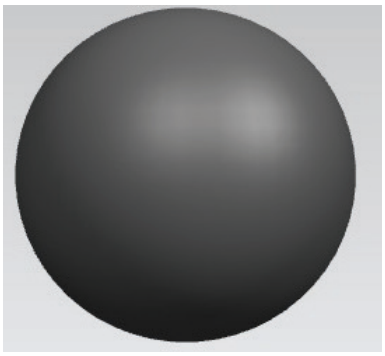
Colour setting for the cutting part	Colour setting for the non-cutting part and shank	Colour setting for the spare part
		
		
“light grey” 80 % white	“medium grey” 50 % white	“iron grey” 30 % white

Figure 4 — Example of colour settings in a CAD system

7 3D model data exchange

7.1 General

For the 3D model data exchange of cutting tools, a differentiation shall be necessary between the cutting and non-cutting geometry.

7.2 Data exchange model structure

Figure 5 to Figure 26 show the structure of the data exchange model.

The data exchange format is determined as defined in ISO 10303-242, known as STEP AP 242. The specification of the data exchange model is defined within the appropriate part of this document.

7.3 Indexable insert tools table

7.3.1 STP Basic and detail format

The indexable insert tools are as shown in Table 1.

Table 1 — Indexable insert tools

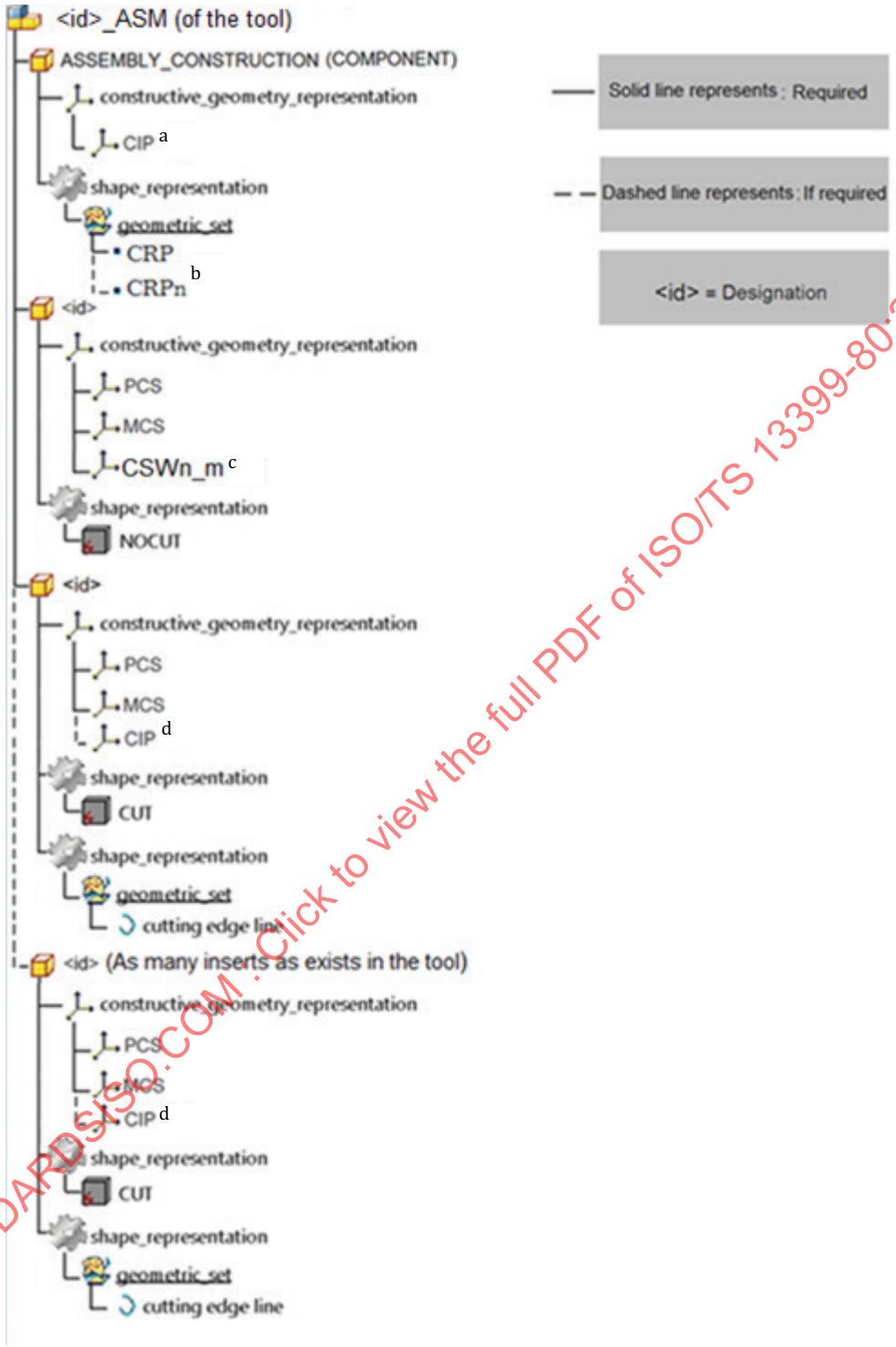
Assembly/Name		Features	Basic STP	Detail STP
Tool (assembly)	i	Axis system	(N/A)	(N/A)
	ii	Solid	(N/A)	(N/A)
	iii	Wireframe	(N/A)	(N/A)
Assembly construction (component) Product.id = ASSEMBLY_CONSTRUCTION	i	Axis system	CIP (for rotating tools except tool with full cutting diameter insert) (N/A) (for stationary tool and rotating tool with full cutting diameter insert).	CIP (for rotating tools except tool with full cutting diameter insert) (N/A) (for stationary tool and rotating tool with full cutting diameter insert).
	ii	Solid	CUT: for rotating tool except tool with full cutting diameter insert (one for each insert level) (N/A): for rotating tool with full cutting diameter insert and Stationary Tool	(N/A)
	iii	Wireframe	CRP (Point — used when there is only one CRP in the tool) or CRPn (Points — used when there is more than one CRP in the tool)	CRP (Point — used when there is only one CRP in the tool) or CRPn (Points — used when there is more than one CRP in the tool)
NOCUT (component)	i	Axis system	MCS PCS CSWn_m[a]	MCS PCS CSWn_m[a]
	ii	Solid	NOCUT	NOCUT
	iii	Wireframe	(N/A)	(N/A)

[a] n_m is optional and when needed (reference to 5.2).

Table 1 *(continued)*

Assembly/Name		Features	Basic STP	Detail STP
CUT (component) If master insert then Product.description = MASTER_INSERT	i	Axis system	MCS PCS CIP (only for rotating tool with full cutting diameter insert).	MCS PCS CIP (only for rotating tool with full cutting diameter insert).
	ii	Solid	(N/A): for rotating tool except tool with full cutting diameter insert. CUT: for stationary tool and rotating tool with full cutting diameter insert (one for each insert in the tool)	CUT (one for each insert in the tool)
	iii	Wireframe	cutting edge line	cutting edge line
[a] n_m is optional and when needed (reference to 5.2).				

7.3.2 Detail STP structure



a For rotating tools, except tools with full cutting diameter insert.

b CRP (Point – used when there is only one CRP in the tool) or CRPn (Points — used when there is more than one CRP in the tool).

c n_m is optional and when needed (reference to 5.2).

d CIP (only for rotating tool with full cutting diameter insert).

Figure 5 — Detail STP tree structure for indexable tool

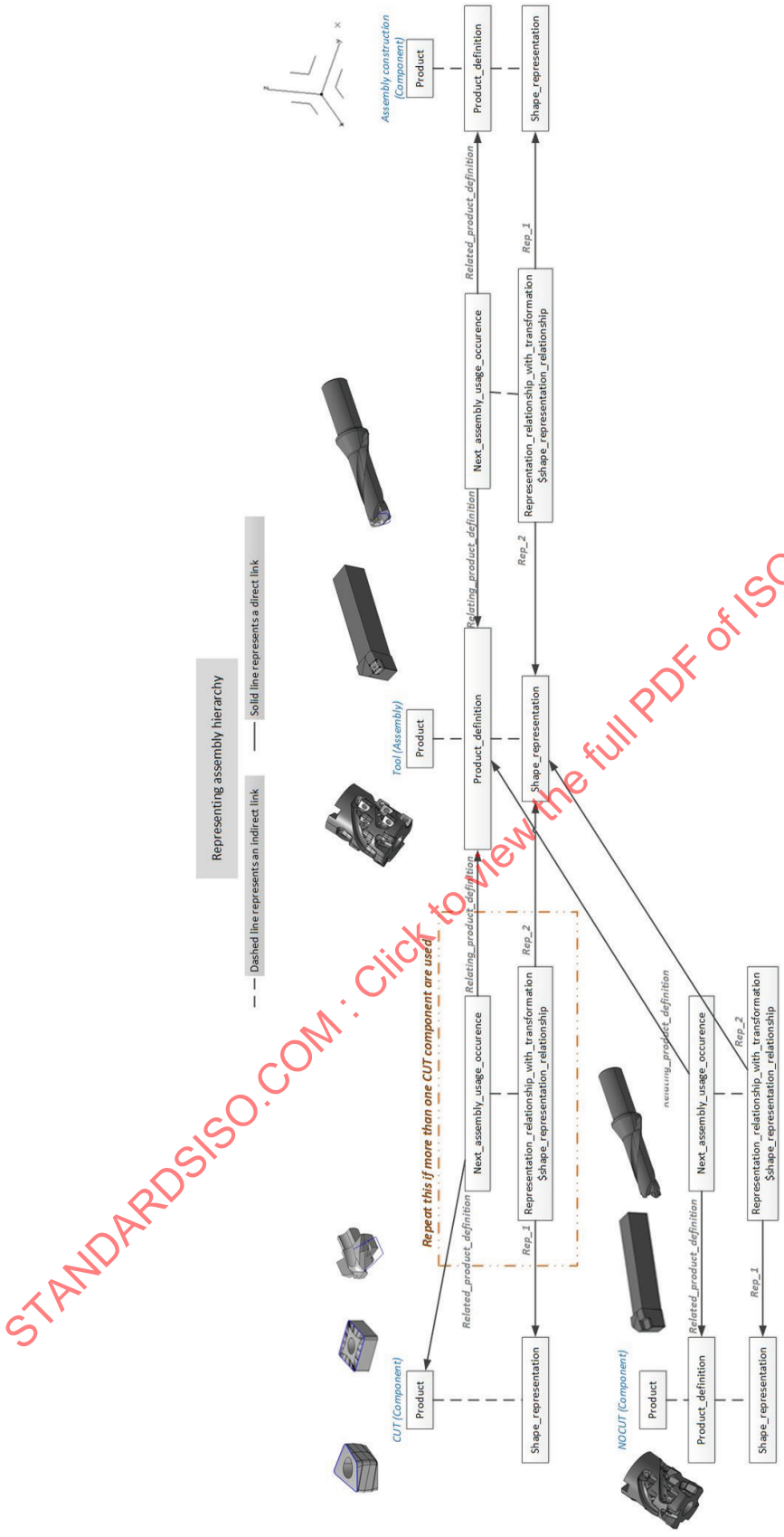
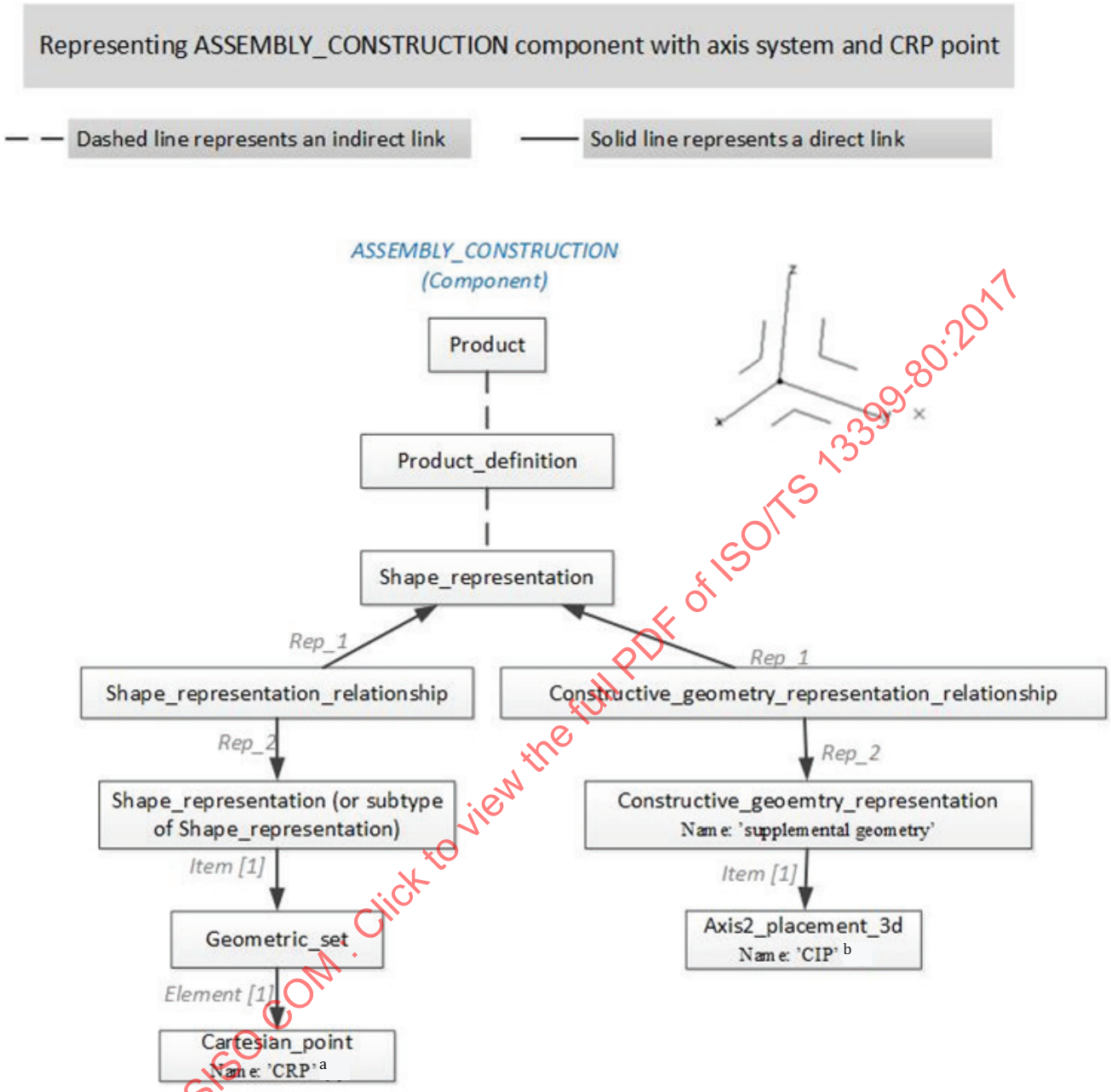


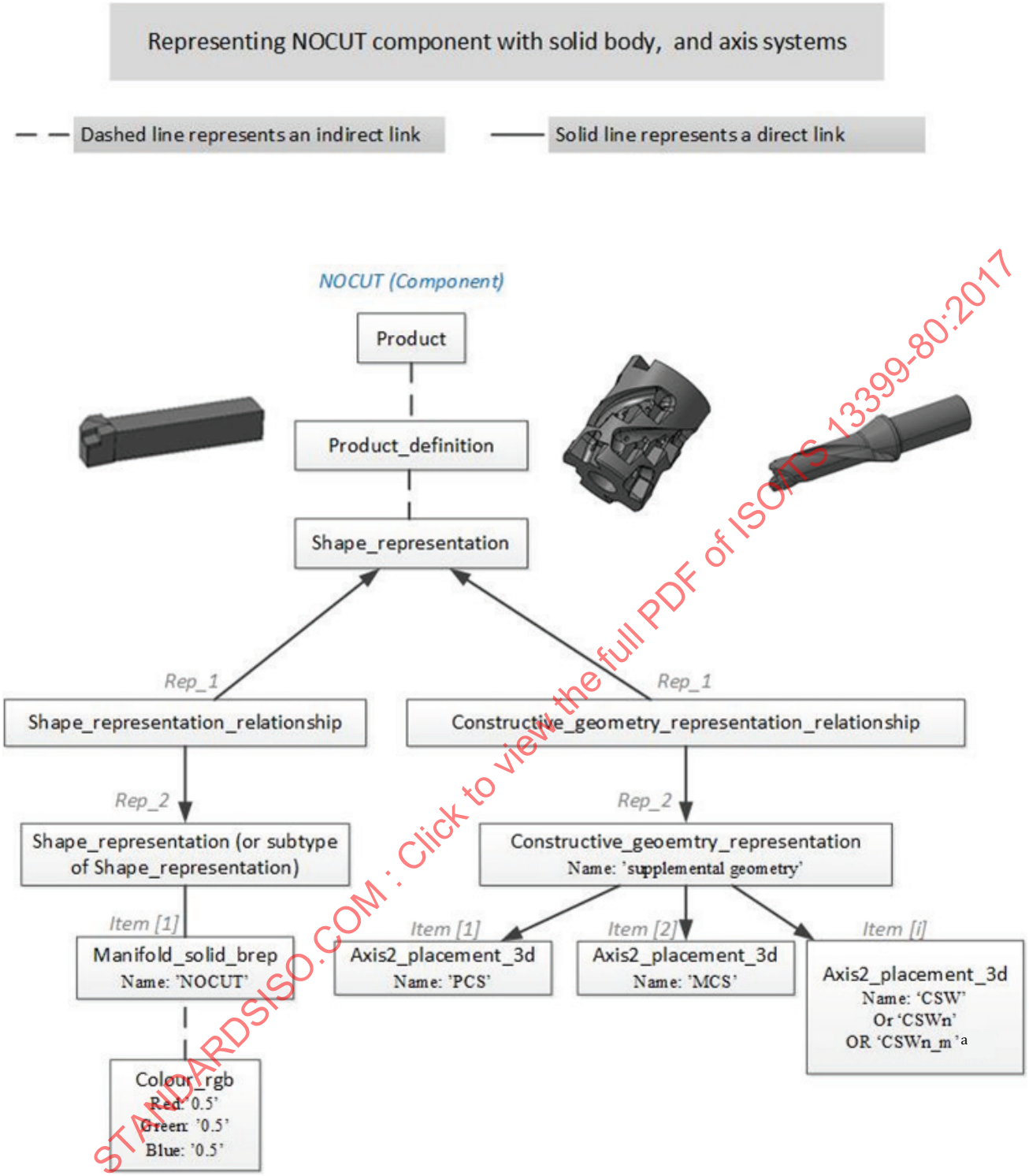
Figure 6 — Detail STP hierarchy structure for indexable tool



a If *n* equals to 1, then the name should read CRP, else the name should read CRP1…CRPn.

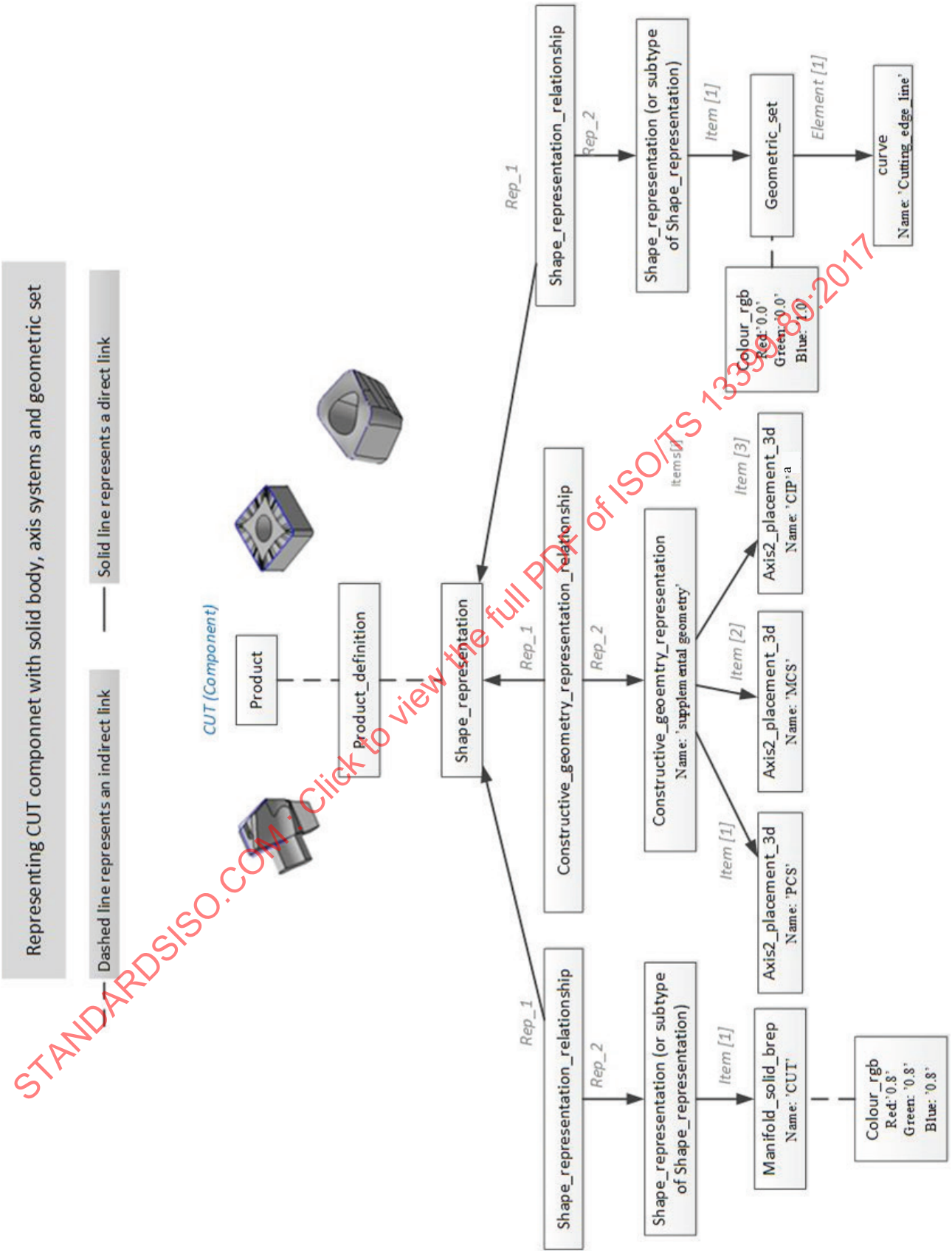
b For rotating tools, except tools with full cutting diameter insert.

Figure 7 — ASSEMBLY_CONSTRUCTION component structure for Detail STP of indexable tool



a n_m is optional and when needed (reference to 5.2).

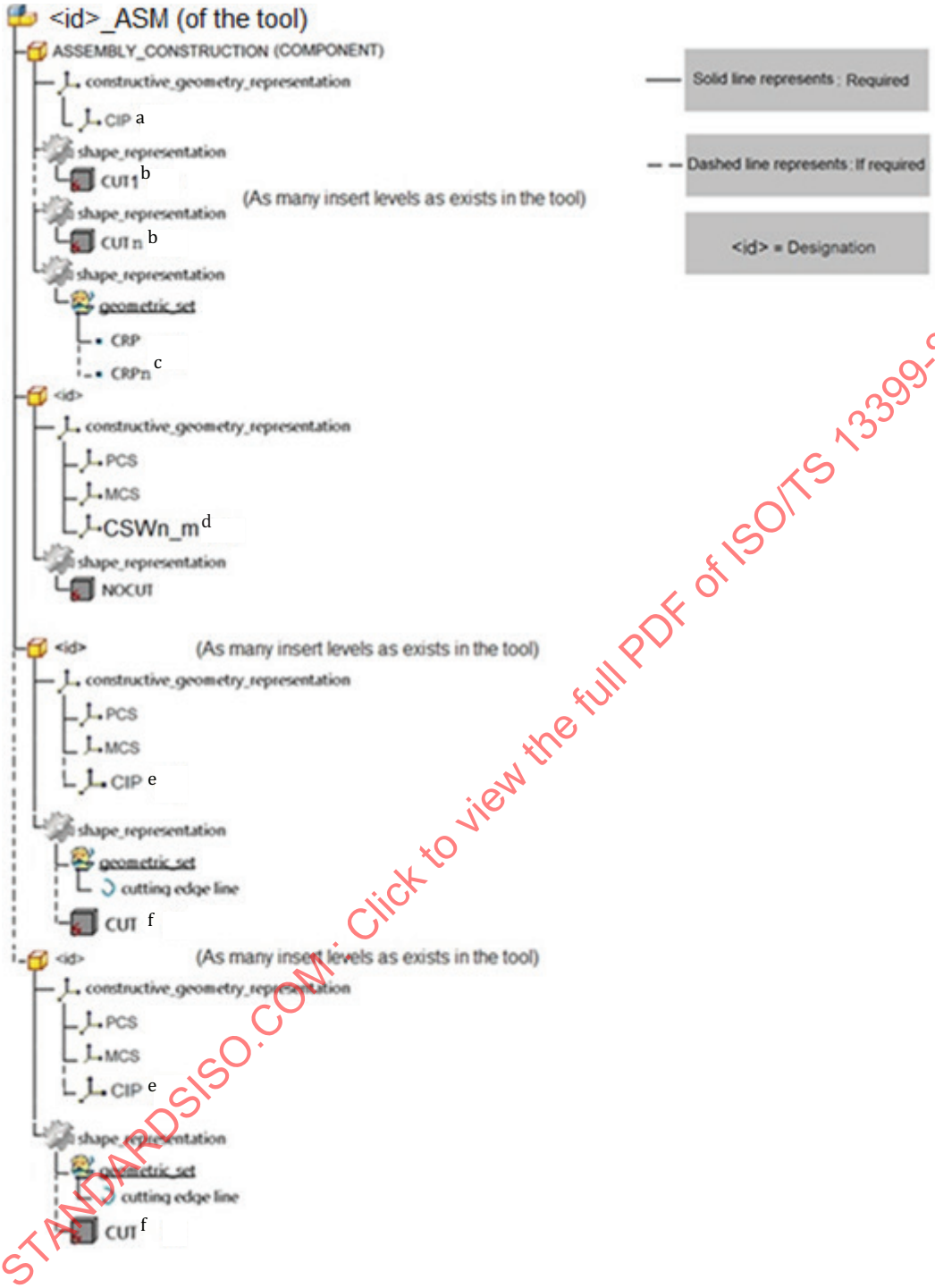
Figure 8 — NOCUT component structure for Detail STP of indexable tool



a Only for rotating tools with full cutting diameter insert.

Figure 9 — CUT component structure for Detail STP of indexable tool

7.3.3 Basic STP structure



a For rotating tools, except tools with full cutting diameter insert.

b For rotating tools, except tools with full cutting diameter insert (one for each insert level).

c CRP (Point – used when there is only one CRP in the tool) or CRPn (Points — used when there is more than one CRP in the tool).

d n_m is optional and when needed (reference to 5.2).

e Only for rotating tools with full cutting diameter insert.

f Only for stationary tools and rotating tools with full cutting diameter insert (one for each insert in the tool).

Figure 10 — Basic STP tree structure for indexable tool

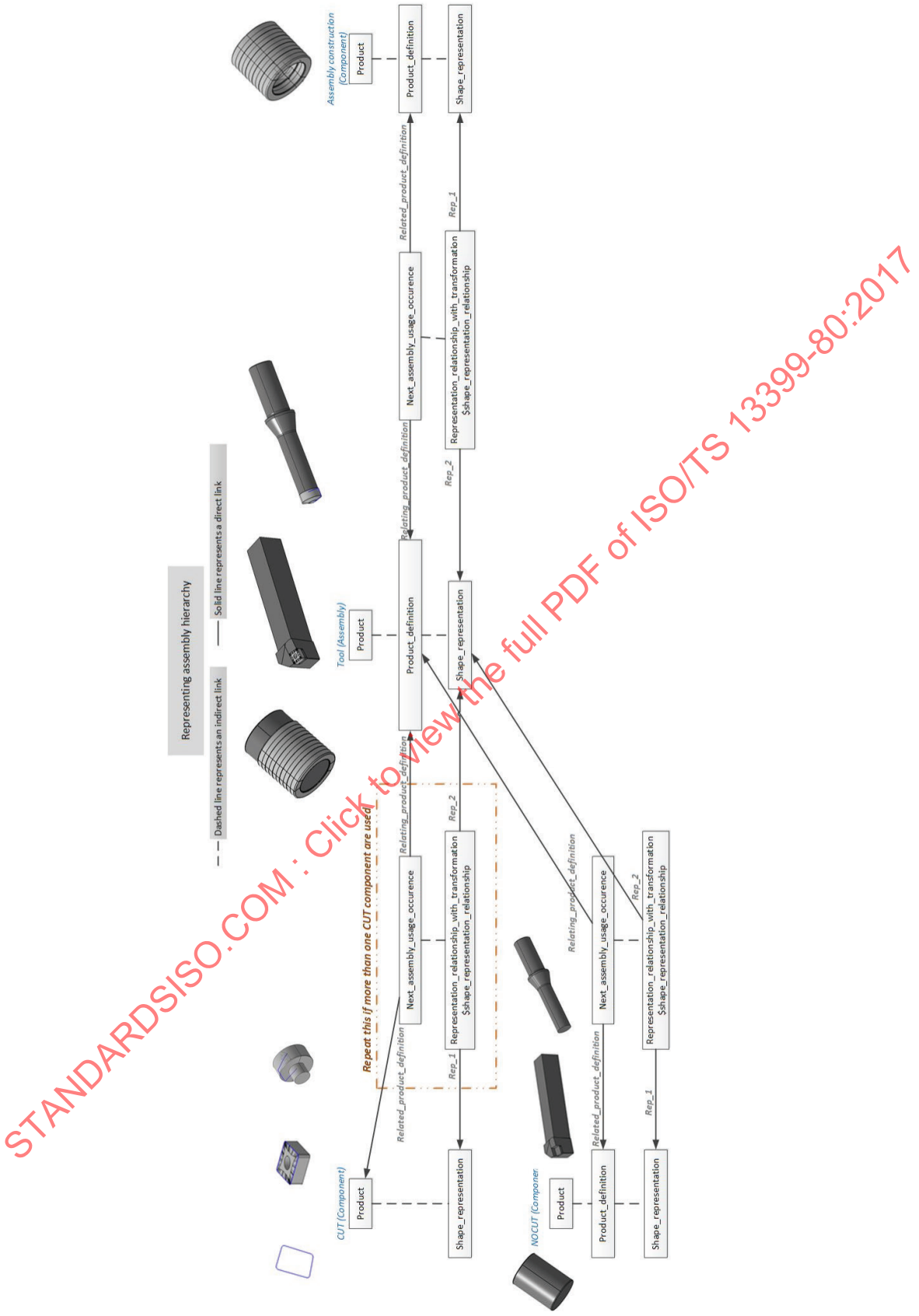
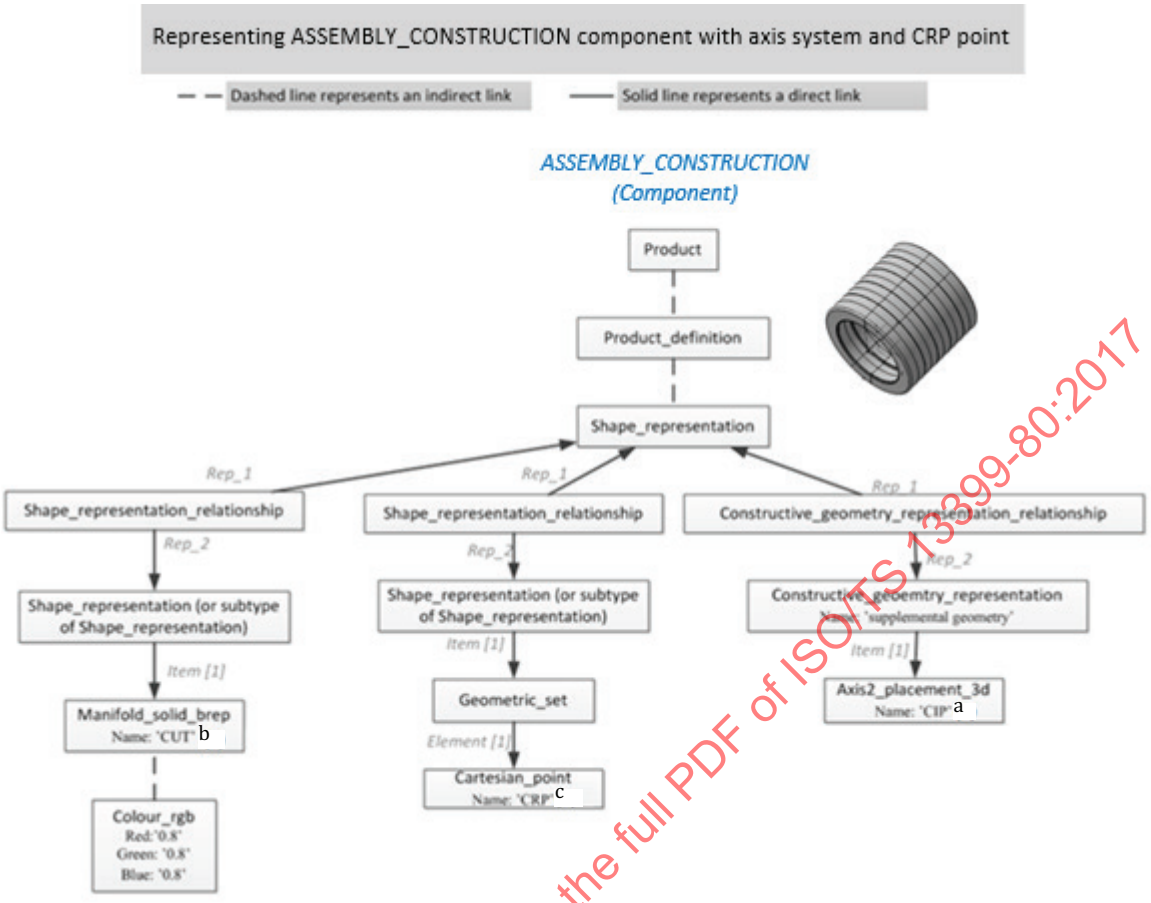


Figure 11 — Basic STP hierarchy structure for indexable tool

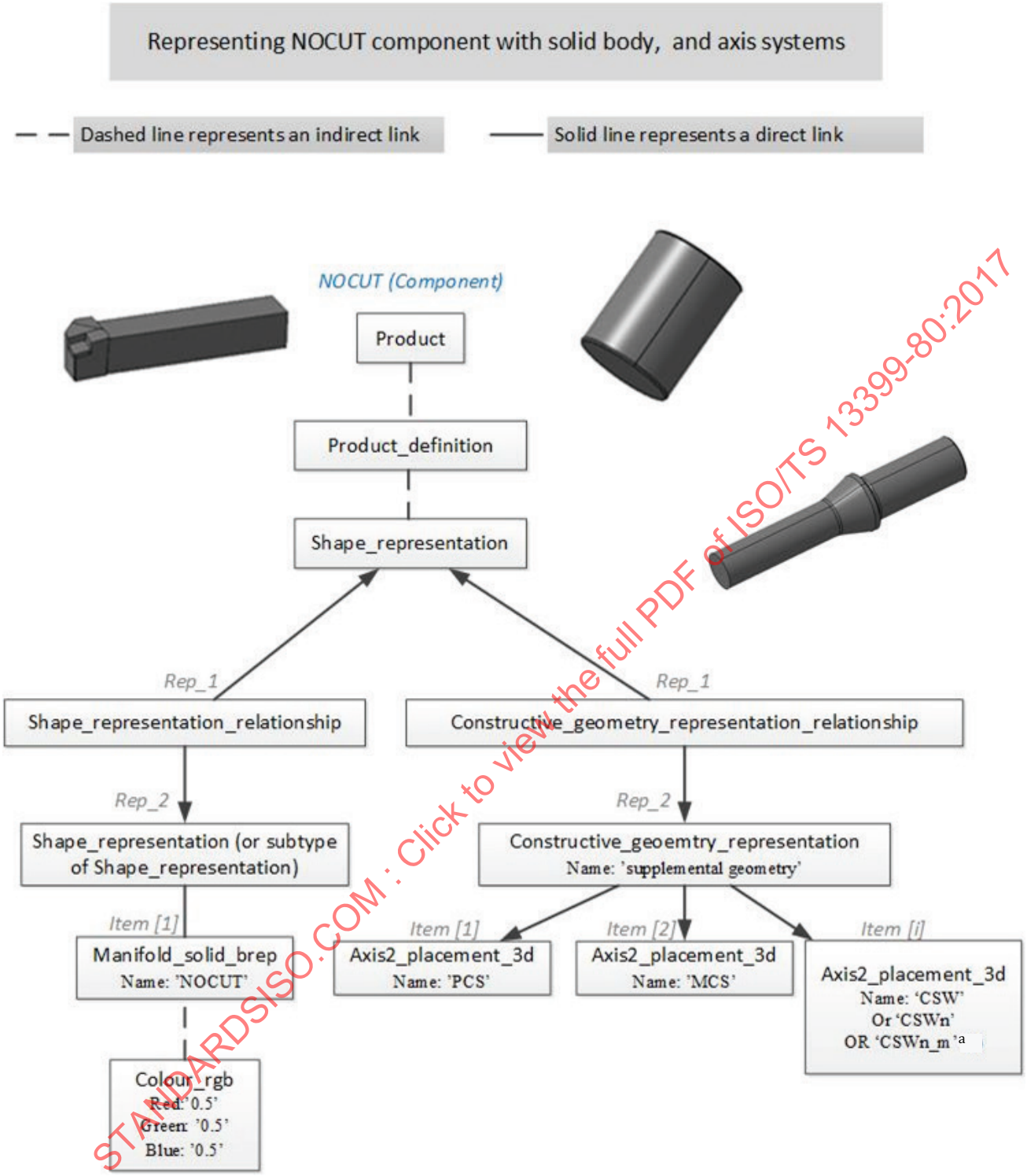


a For rotating tools, except tools with full cutting diameter insert.

b For rotating tools, except tools with full cutting diameter insert (one for each insert level).

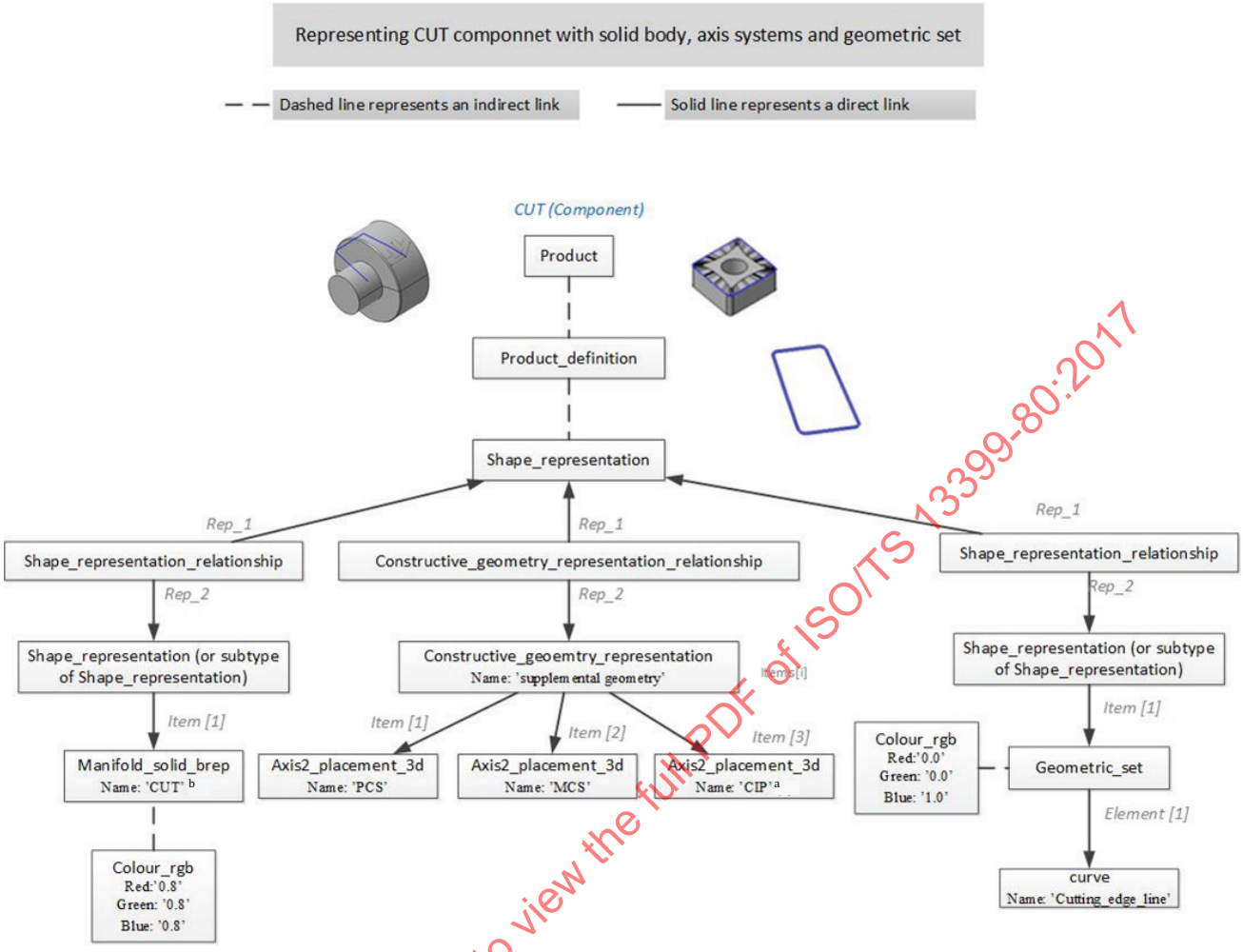
c CRP (Point – used when there is only one CRP in the tool) or CRPn (Points — used when there is more than one CRP in the tool).

Figure 12 — ASSEMBLY_CONSTRUCTION component structure for Basic STP of indexable tool



a Indexing according to 5.2.2.

Figure 13 — NOCUT component structure for Detail STP of indexable tool



Key

a Only for rotating tools with full cutting diameter insert.

b For stationary tools and rotating tool with full cutting diameter insert (one for each insert in the tool).

Figure 14 — CUT component structure for Detail STP of indexable tool

7.4 Non-indexable tools table

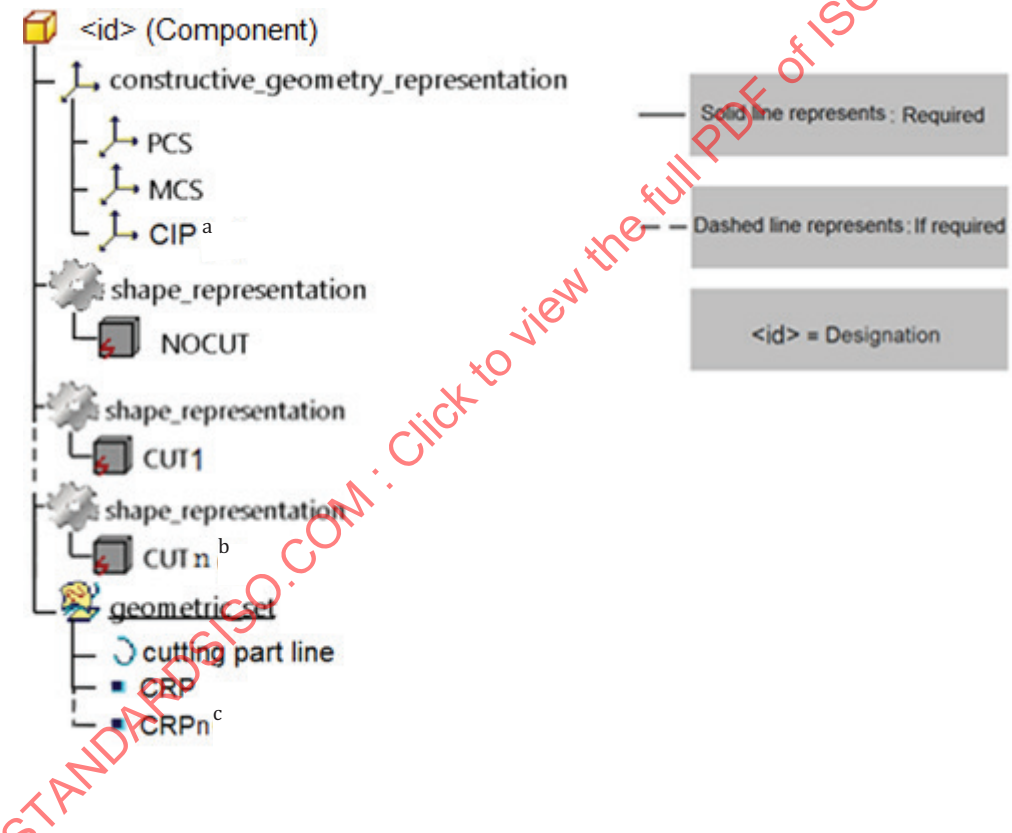
7.4.1 STP basic and detail format

The non-indexable insert tools are as shown in Table 2.

Table 2 — Non-indexable tools

Assembly/Name		Features	Basic STP	Detail STP
Tool (component)	i	Axis system	PCS	PCS
			MCS	MCS
			CIP (for rotating tools only)	CIP (for rotating tools only)
	ii	Solid	NOCUT	NOCUT
			CUT or CUTn (if there is more than one cut)	CUT or CUTn (if there is more than one cut)
	iii	wireframe	Cutting part line	Cutting part line
			CRP (Point – used when there is only one CRP in the tool) or CRPn (Points — used when there is more than one CRP in the tool)	CRP (Point – used when there is only one CRP in the tool) or CRPn (Points — used when there is more than one CRP in the tool)

7.4.2 Detail STP structure

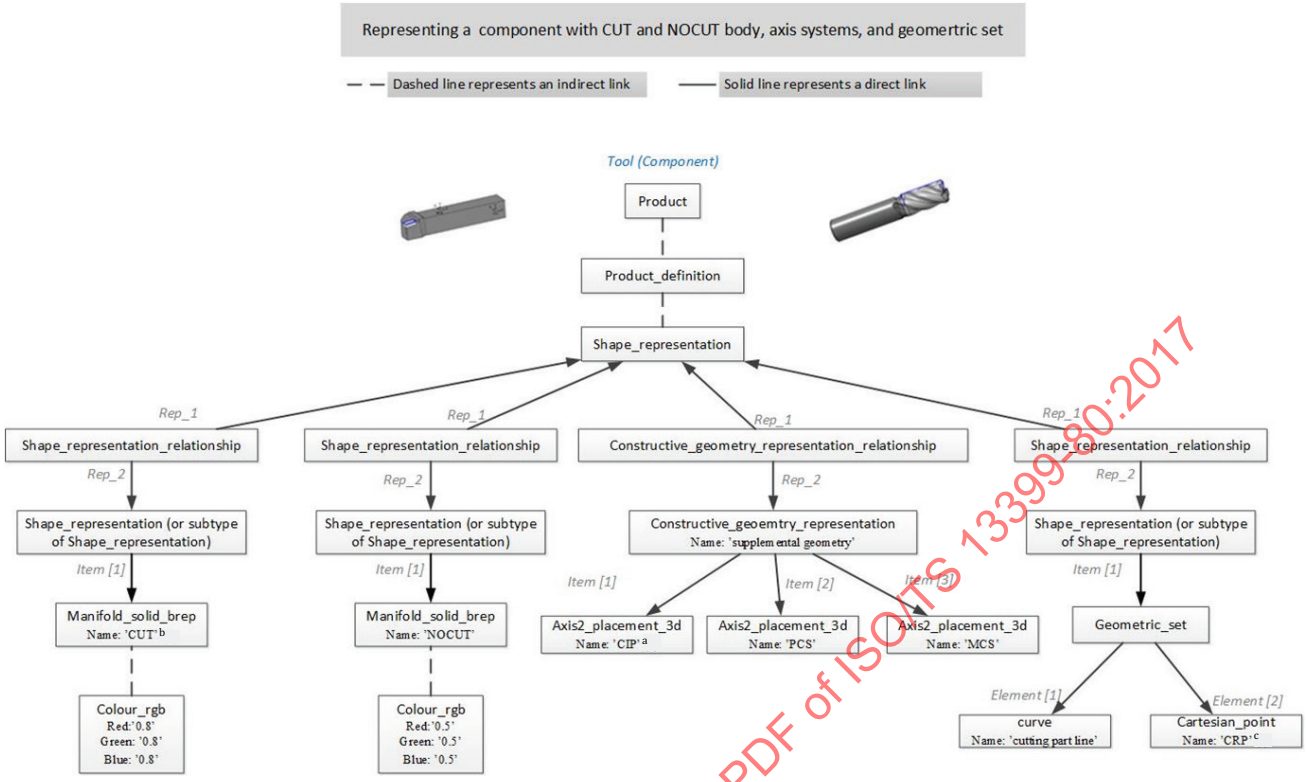


a For rotating tools only.

b If there is more than one cut.

c CRP (Point – used when there is only one CRP in the tool) or CRPn (Points — used when there is more than one CRP in the tool).

Figure 15 — Detail STP tree structure for NON-indexable tool



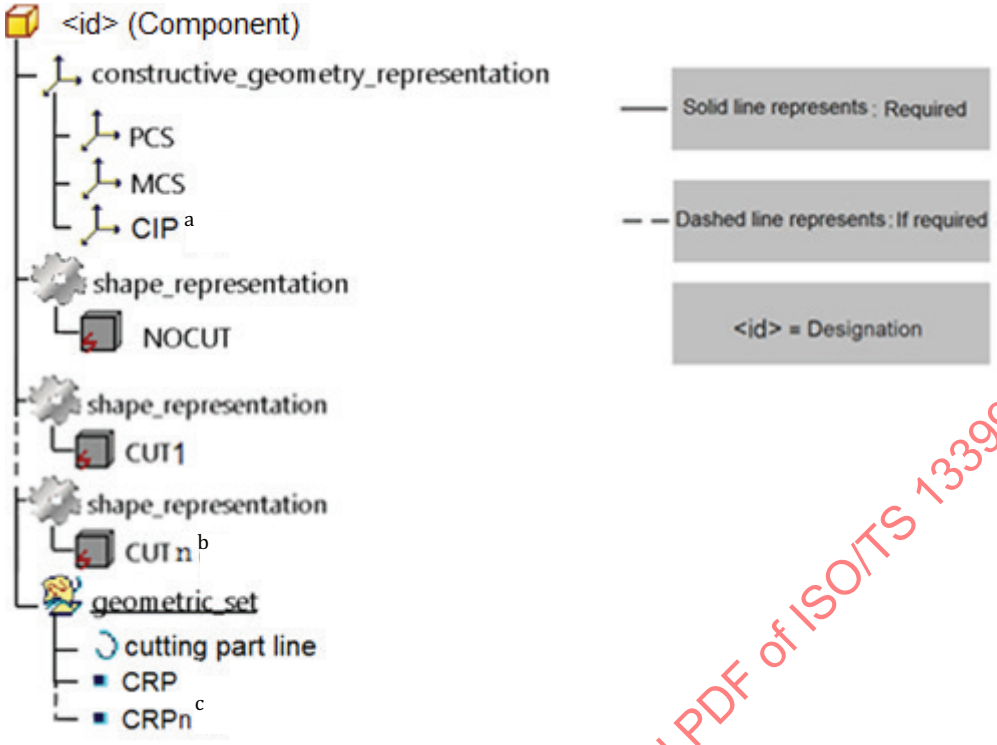
a For rotating tools only.

b If there is more than one cut.

c CRP (Point – used when there is only one CRP in the tool) or CRPn (Points — used when there is more than one CRP in the tool).

Figure 16 — Detail STP hierarchy structure for NON-indexable tool

7.4.3 Basic STP structure

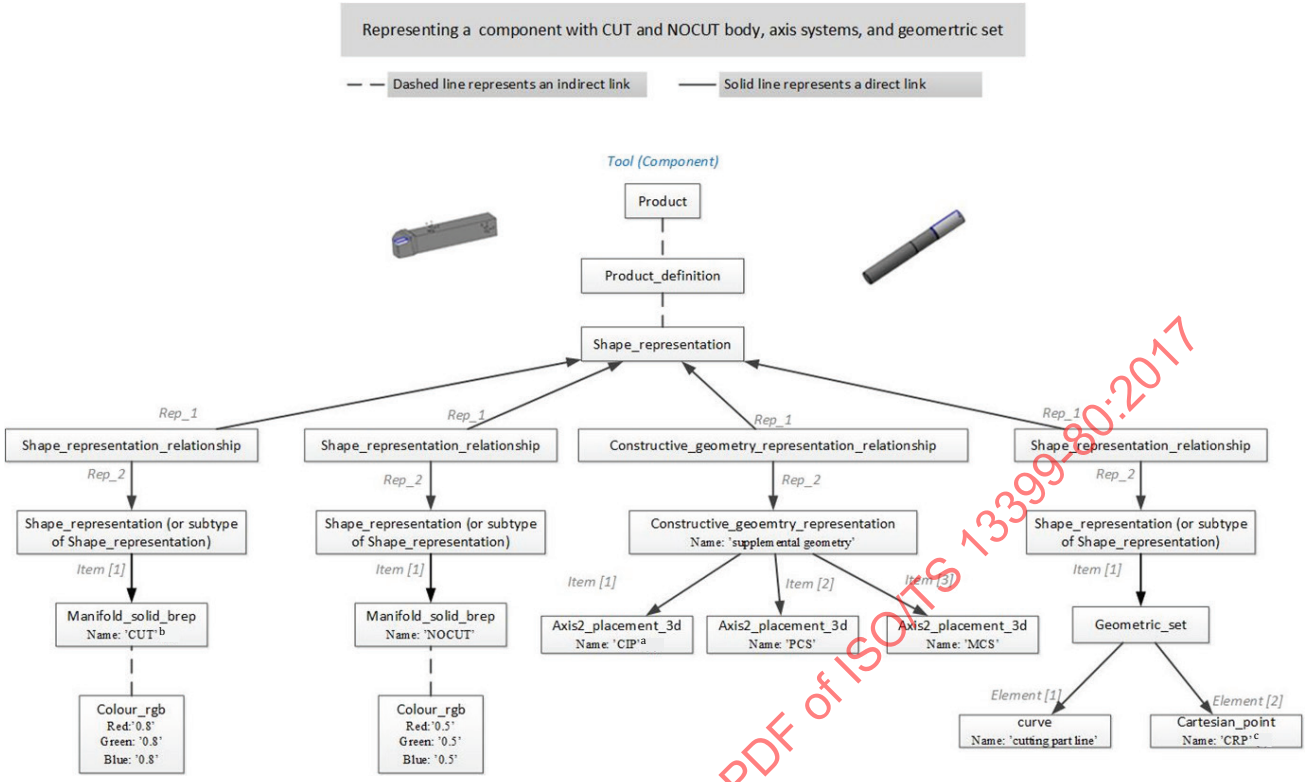


a For rotating tools only.

b If there is more than one cut.

c CRP (Point – used when there is only one CRP in the tool) or CRPn (Points — used when there is more than one CRP in the tool).

Figure 17 — Basic STP tree structure for NON-indexable tool



a For rotating tools only.

b If there is more than one cut.

c CRP (Point – used when there is only one CRP in the tool) or CRPn (Points — used when there is more than one CRP in the tool).

Figure 18 — Basic STP hierarchy structure for NON-indexable tool

7.5 Cutting item table

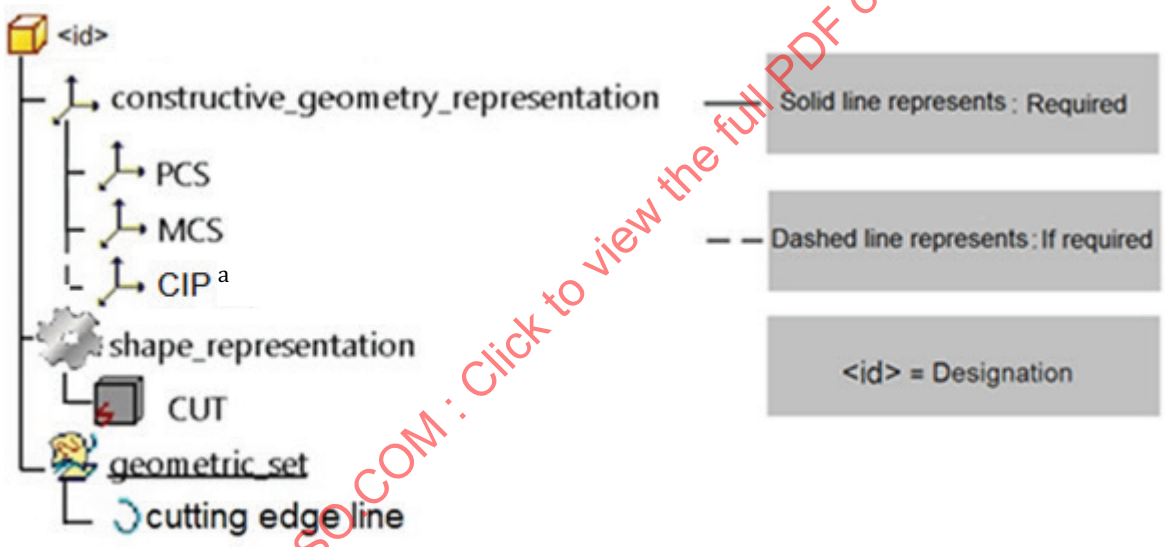
7.5.1 STP basic and detail format

The cutting items are as shown in Table 3.

Table 3 — Cutting items

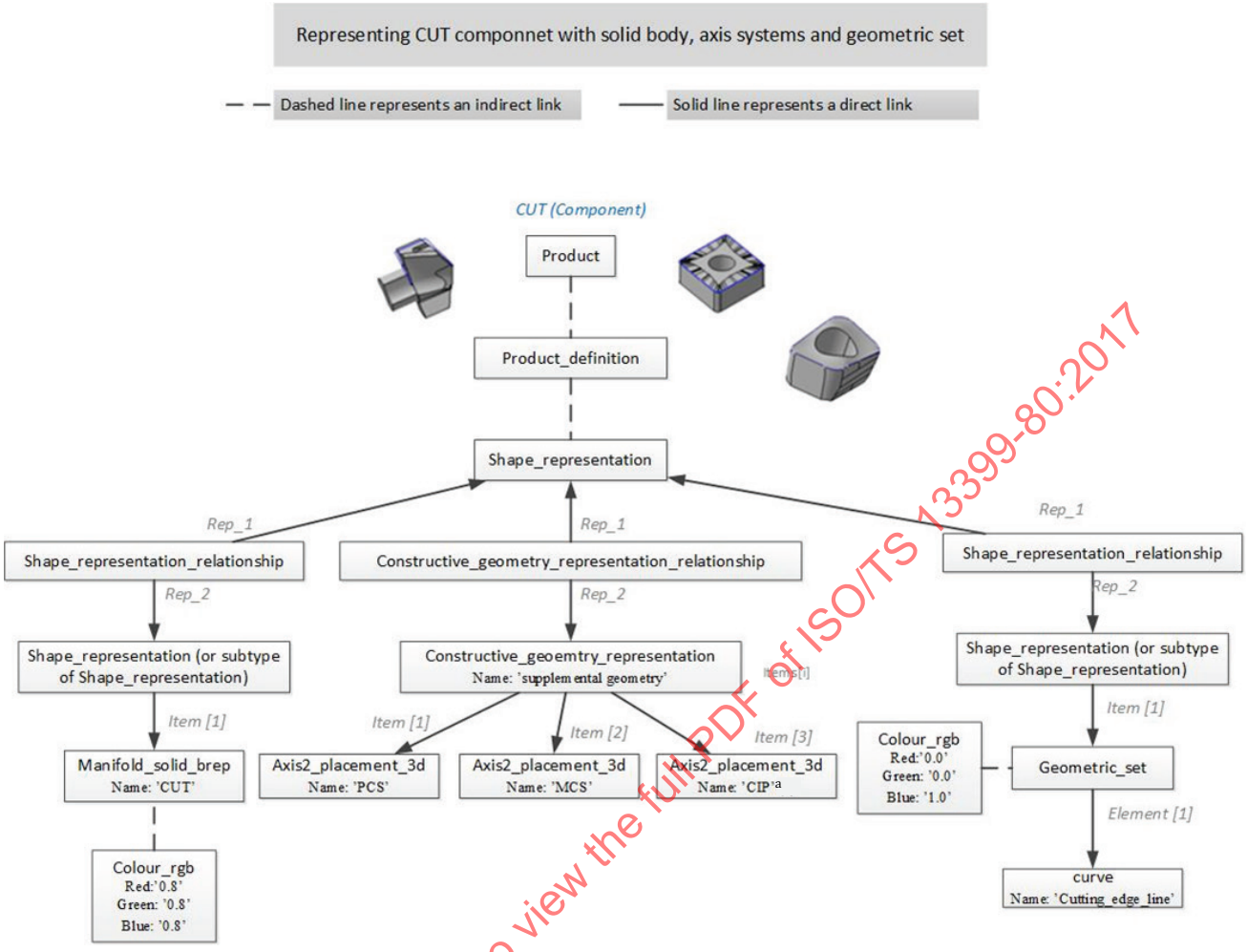
Component		Features	Basic STP (only when used in rotating tools)	Detail STP
Tool (Component) If a master insert then Product.Description: = MASTER_INSERT	i	Axis system	PCS	PCS
			MCS	MCS
			(N/A) CIP (only for full cutting diameter insert, refer to ISO/TS 13399-203)	(N/A) CIP (only for full cutting diameter insert, refer to ISO/TS 13399-203)
	ii	Solid	(N/A) CUT - for full cutting diameter inserts on rotating tool and inserts for stationary tool	CUT
	iii	Wireframe	Cutting edge line	Cutting edge line

7.5.2 Detail STP structure



a For rotating tools only.

Figure 19 — Cutting item tree structure for Detail STP



a Only for full cutting diameter inserts, refer to ISO/TS 13399-203.

Figure 20 — CUT component structure for Detail STP of cutting item