MTConnect® Standard

Part 4.1 – Cutting Tools

Version 1.5.0

Prepared for: MTConnect Institute
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MTConnect Specification and Materials

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1 Purpose of This Document

This document, *MTConnect Standard: Part 4.1 - Cutting Tools* of the MTConnect Standard, establishes the rules and terminology to be used by designers to describe the function and operation of cutting tools used within manufacturing and to define the data that is provided by an *Agent* from a piece of equipment. This part of the Standard also defines the structure for the XML document that is returned from an *Agent* in response to a `probe` request.

The data associated with these cutting tools will be retrieved from multiple sources that are responsible for providing their knowledge of an *MTConnect Asset*.

2 Terminology and Conventions

Refer to Section 2 of *MTConnect Standard Part 1.0 - Overview and Fundamentals* for a dictionary of terms, reserved language, and document conventions used in the MTConnect Standard.

2.1 Glossary

Agent

Refers to an MTConnect Agent.

Software that collects data published from one or more piece(s) of equipment, organizes that data in a structured manner, and responds to requests for data from client software systems by providing a structured response in the form of a *Response Document* that is constructed using the *semantic data models* defined in the Standard.

Appears in the documents in the following form: *Agent*.

Asset Document

An electronic document published by an *Agent* in response to a *Request* for information from a client software application relating to Assets.

Document

General meaning:

A piece of written, printed, or electronic matter that provides information.

Used to represent an *MTConnect Document*:

Refers to printed or electronic document(s) that represent a *Part*(s) of the MTConnect Standard.

Appears in the documents in the following form: *MTConnect Document*.

Used to represent a specific representation of an *MTConnect Document*:

Refers to electronic document(s) associated with an *Agent* that are encoded using XML; *Response Documents* or *Asset Documents*.

Appears in the documents in the following form: *MTConnect XML Document*.

Used to describe types of information stored in an *Agent*:

In an implementation, the electronic documents that are published from a data source and stored by an *Agent*.

Appears in the documents in the following form: *Asset Document*.

Used to describe information published by an *Agent*:

A document published by an *Agent* based upon one of the *semantic data models* defined in the MTConnect Standard in response to a request from a client.

Appears in the documents in the following form: *Response Document*.

MTConnect Document

See *Document*.

MTConnect XML Document

See *Document*.

Response Document

See *Document*.

semantic data model

A methodology for defining the structure and meaning for data in a specific logical way.

It provides the rules for encoding electronic information such that it can be interpreted by a software system.

Appears in the documents in the following form: *semantic data model*.

2.2 Acronyms

AMT

The Association for Manufacturing Technology

2.3 MTConnect References

[MTConnect Part 1.0] *MTConnect Standard Part 1.0 - Overview and Fundamentals*. Version 1.5.0.

[MTConnect Part 4.1] *MTConnect Standard: Part 4.1 - Cutting Tools*. Version 1.5.0.

3 Assets Model

3.1 AssetModel

3.1.1 Asset

An Asset is something that is used in the manufacturing process, but is not permanently associated with a single piece of equipment, can be removed from the piece of equipment without compromising its function, and can be associated with other pieces of equipment during its lifecycle.

Table 1: `Properties of Asset`

Property	Type	Multiplicity
`assetId`	`ID`	1
`deviceUuid`	`NMTOKEN`	1
`removed`	`boolean`	0..1
`timestamp`	`dateTime`	1
`Description`	`Description`	0..1

3.1.1.1 `assetId`

The unique identifier for an Asset.

3.1.1.2 `deviceUuid`

The piece of equipment's uuid that supplied the Asset's data.

3.1.1.3 `removed`

An indicator that the Asset has been removed from the piece of equipment.

3.1.1.4 `timestamp`

The point in time time the Asset data was last modified.

3.1.1.5 Description

Placeholder for documentation!

3.2 CuttingToolModel

3.2.1 CuttingTool

Subtype of Asset

A CuttingTool physically removes the material from the workpiece by shear deformation.

Table 2: Properties of CuttingTool

Property	Type	Multipl
manufacturers	string	0..1
serialNumber	string	1
toolId	string	1
CuttingToolLifeCycle	CuttingToolLifeCycle	0..1
CuttingToolArchetypeReference	CuttingToolArchetypeReference	0..1
«deprecated» CuttingToolDefinition	CuttingToolDefinition	0..1

3.2.1.1 manufacturers

The manufacturers of the Cutting Item or Tool.

3.2.1.2 serialNumber

The unique identifier for this assembly.

3.2.1.3 toolId

The identifier for a class of cutting tools.

3.2.1.4 CuttingToolLifeCycle

Placeholder for documentation!

3.2.1.5 CuttingToolArchetypeReference

Placeholder for documentation!

3.2.1.6 CuttingToolDefinition

Placeholder for documentation!

3.2.2 CuttingToolArchetype

Subtype of Asset

The CuttingToolArchetype represents the static cutting tool geometries and nominal values as one would expect from a tool catalog.

Table 3: Properties of CuttingToolArchetype

Property	Type	Multiplicity
manufacturers	string	0..1
serialNumber	string	1
toolId	string	1
CuttingToolDefinition	CuttingToolDefinition	0..1
CuttingToolLifeCycle	CuttingToolLifeCycle	0..1

3.2.2.1 manufacturers

Placeholder for documentation!

3.2.2.2 serialNumber

The unique identifier for this assembly.

3.2.2.3 toolId

The identifier for a class of cutting tools.

3.2.2.4 CuttingToolDefinition

Placeholder for documentation!

3.2.2.5 CuttingToolLifeCycle

Placeholder for documentation!

3.2.3 CuttingToolArchetypeReference

CuttingToolArchetypeReference has reference information about the assetId and/or the URL of the data source of CuttingToolArchetype.

Table 4: Properties of CuttingToolArchetypeReference

Property	Type	Multiplicity
source	string	0..1
value	CuttingToolArchetype	0..1

3.2.3.1 source

The URL of the CuttingToolArchetype Information Model.

3.2.3.2 value

Placeholder for documentation!

3.2.4 CuttingToolDefinition

Reference to an ISO 13399.

Table 5: `Properties of CuttingToolDefinition`

Property	Type	Multiplicity
`format`	`FormatType`	0..1
`value`	`string`	0..*

3.2.4.1 `format`

Identifies the expected representation of the enclosed data.

Enumeration for CuttingToolDefinition format values.

Table 6: `FormatType` Enumeration

Name	Description
`EXPRESS`	The document will confirm to the ISO 10303 Part 21 standard.
`TEXT`	The document will be a text representation of the tool data.
`UNDEFINED`	The document will be provided in an undefined format.
`XML`	The default value for the definition. The content will be an XML document.

3.2.4.2 `value`

Placeholder for documentation!

3.2.5 CuttingToolLifeCycle

Data regarding the use of the cutting tool.

Table 7: `Properties of CuttingToolLifeCycle`

Property	Type	Multiplicity
ConnectionCodeMachineSide	string	0..1
ProgramToolGroup	string	0..1
ProgramToolNumber	integer	0..1
ProcessFeedRate	ProcessFeedRate	0..1
ToolLife	ToolLife	0..1
ToolLife	ToolLife	0..1
ProcessSpindleSpeed	ProcessSpindleSpeed	0..1
ToolLife	ToolLife	0..1
CutterStatus	Status	1..*
CuttingItems	CuttingItem	0..*
Measurements	Measurement	0..*
ReconditionCount	ReconditionCount	0..1
Location	Location	0..1

3.2.5.1 ConnectionCodeMachineSide

Identifier for the capability to connect any Component of the cutting tool together, except Assembly Items, on the machine side. Code: CCMS

3.2.5.2 ProgramToolGroup

The tool group this tool is assigned in the part program.

3.2.5.3 ProgramToolNumber

The number of the tool as referenced in the part program.

3.2.5.4 ProcessFeedRate

Placeholder for documentation!

3.2.5.5 ToolLife

Placeholder for documentation!

3.2.5.6 ToolLife

Placeholder for documentation!

3.2.5.7 ProcessSpindleSpeed

Placeholder for documentation!

3.2.5.8 ToolLife

Placeholder for documentation!

3.2.5.9 CutterStatus

Placeholder for documentation!

3.2.5.10 CuttingItems

Placeholder for documentation!

3.2.5.11 Measurements

Placeholder for documentation!

3.2.5.12 ReconditionCount

Placeholder for documentation!

3.2.5.13 Location

Placeholder for documentation!

3.2.6 Location

The Pot or Spindle the cutting tool currently resides in.

Table 8: `Properties of Location`

Property	Type	Multiplicity
`negativeOverlap`	`integer`	0..1
`positiveOverlap`	`integer`	0..1
`type`	`LocationType`	1

3.2.6.1 `negativeOverlap`

The number of location at lower index values from this location.

3.2.6.2 `positiveOverlap`

The number of locations at higher index value from this location.

3.2.6.3 `type`

The type of location being identified.

Enumeration for Location types

Table 9: `LocationType` Enumeration

Name	Description
`POT`	The number of the pot in the tool handling system.
`STATION`	The tool location in a horizontal turning machine.
`CRIB`	The location with regard to a tool crib.

3.2.7 Measurement

A constrained scalar value associated with this cutting tool.

Table 10: `Properties of Measurement`

Property	Type	Multiplicity
`code`	`CodeEnum`	1
`maximum`	`float`	0..1
`minimum`	`float`	0..1
`nativeUnits`	`NativeUnitEnum`	0..1
`nominal`	`float`	0..1
`significantDigits`	`integer`	0..1
`units`	`UnitEnum`	0..1

3.2.7.1 `code`

A shop specific code for this measurement. ISO 13399 codes MAY be used for these codes as well.

Placeholder for documentation!

Table 11: `CodeEnum` Enumeration

Name	Description
BDX	The largest diameter of the body of a Tool Item.
LBX	The distance measured along the X axis from that point of the item closest to the workpiece, including the Cutting Item for a Tool Item but excluding a protruding locking mechanism for an Adaptive Item, to either the front of the flange on a flanged body or the beginning of the connection interface feature on the machine side for cylindrical or prismatic shanks.
APMX	The maximum engagement of the cutting edge or edges with the workpiece measured perpendicular to the feed motion.
DC	The maximum diameter of a circle on which the defined point Pk of each of the master inserts is located on a Tool Item. The normal of the machined peripheral surface points towards the axis of the Cutting Tool.
DF	The dimension between two parallel tangents on the outside edge of a flange.
OAL	The largest length dimension of the Cutting Tool including the master insert where applicable.
DMM	The dimension of the diameter of a cylindrical portion of a Tool Item or an Adaptive Item that can participate in a connection.
H	The dimension of the height of the shank.
LS	The dimension of the length of the shank.
LUX	Maximum length of a Cutting Tool that can be used in a particular cutting operation including the non-cutting portions of the tool.
LPR	The dimension from the yz-plane to the furthest point of the Tool Item or Adaptive Item measured in the -X direction.
WT	The total weight of the Cutting Tool in grams. The force exerted by the mass of the Cutting Tool.
LF	The distance from the gauge plane or from the end of the shank to the furthest point on the tool, if a gauge plane does not exist, to the cutting reference point determined by the main function of the tool. The model:CuttingTool functional length will be the length of the entire tool, not a single Cutting Item. Each model:CuttingItem can have an independent model:FunctionalLength represented in its measurements.
CRP	The theoretical sharp point of the Cutting Tool from which the major functional dimensions are taken.
L	The theoretical length of the cutting edge of a Cutting Item over sharp corners.
DRVA	Angle between the driving mechanism locator on a Tool Item and the main cutting edge.
WF	The distance between the cutting reference point and the rear backing surface of a turning tool or the axis of a boring bar.
IC	The diameter of a circle to which all edges of a equilateral and round regular insert are tangential.
SIG	The angle between the major cutting edge and the same cutting edge rotated by 180 degrees about the tool axis.
KAPR	The angle between the tool cutting edge plane and the tool feed plane measured in a plane parallel the xy-plane.

3.2.7.2 maximum

The maximum value for this measurement.

3.2.7.3 minimum

The minimum value for this measurement.

3.2.7.4 nativeUnits

The units the measurement was originally recorded in.

Placeholder for documentation!

Table 12: `NativeUnitEnum` Enumeration

Name	Description
CENTIPOISE	Placeholder for documentation!
DEGREE/MINUTE	Placeholder for documentation!
FAHRENHEIT	Placeholder for documentation!
FOOT	Placeholder for documentation!
FOOT/MINUTE	Placeholder for documentation!
FOOT/SECOND	Placeholder for documentation!
FOOT/SECOND$\hat{2}$	Placeholder for documentation!
FOOT_3D	Placeholder for documentation!
GALLON/MINUTE	Placeholder for documentation!
HOUR	Placeholder for documentation!
INCH	Placeholder for documentation!
INCH/MINUTE	Placeholder for documentation!
INCH/SECOND	Placeholder for documentation!
INCH/SECOND$\hat{2}$	Placeholder for documentation!
INCH_POUND	Placeholder for documentation!
INCH_3D	Placeholder for documentation!
KELVIN	Placeholder for documentation!
KILOWATT	Placeholder for documentation!
KILOWATT_HOUR	Placeholder for documentation!
LITER	Placeholder for documentation!
LITER/MINUTE	Placeholder for documentation!
MILLIMETER/MINUTE	Placeholder for documentation!
MINUTE	Placeholder for documentation!
OTHER	Placeholder for documentation!
POUND	Placeholder for documentation!
POUND/INCH$\hat{2}$	Placeholder for documentation!
RADIAN	Placeholder for documentation!
RADIAN/MINUTE	Placeholder for documentation!
RADIAN/SECOND	Placeholder for documentation!
RADIAN/SECOND$\hat{2}$	Placeholder for documentation!
REVOLUTION/SECOND	Placeholder for documentation!

3.2.7.5 `nominal`

The as advertised value for this measurement.

3.2.7.6 `significantDigits`

The number of significant digits in the reported value.

3.2.7.7 `units`

The units for the measurements.

Placeholder for documentation!

Table 13: `UnitEnum` Enumeration

Name	Description
AMPERE	Amps
CELSIUS	Degrees Celsius
COUNT	A count of something.
DECIBEL	Sound Level
DEGREE	Angle in degrees
DEGREE/SECOND	Angular degrees per second
DEGREE/SECOND$\hat{2}$	Angular acceleration in degrees per second squared
HERTZ	Frequency measured in cycles per second
JOULE	A measurement of energy.
KILOGRAM	Kilograms
LITER	Measurement of volume of a fluid
LITER/SECOND	Liters per second
MICRO_RADIAN	Measurement of Tilt
MILLIMETER	Millimeters
MILLIMETER_3D	A point in space identified by X, Y, and Z positions and represented by a space-delimited set of numbers each expressed in millimeters.
MILLIMETER/REVOLUTION	Millimeters per revolution.
MILLIMETER/SECOND	Millimeters per second
MILLIMETER/SECOND$\hat{2}$	Acceleration in millimeters per second squared
NEWTON	Force in Newtons
NEWTON_METER	Torque, a unit for force times distance.
OHM	Measure of Electrical Resistance
PASCAL	Pressure in Newtons per square meter
PASCAL_SECOND	Measurement of Viscosity
PERCENT	Percentage
PH	A measure of the acidity or alkalinity of a solution.
REVOLUTION/MINUTE	Revolutions per minute
SECOND	A measurement of time.
SIEMENS/METER	A measurement of Electrical Conductivity
VOLT	Volts
VOLT_AMPERE	The measurement of the apparent power in an electrical circuit, equal to the product of root-mean-square (RMS) voltage and RMS current (commonly referred to as VA).
VOLT_AMPERE_REACTIVE	The measurement of reactive power in an AC electrical circuit (commonly referred to as VAR).
WATT	Watts
WATT_SECOND	Measurement of electrical energy, equal to one Joule

3.2.8 ProcessFeedRate

The constrained process feed rate for this tool in mm/s.

Table 14: `Properties of ProcessFeedRate`

Property	Type	Multiplicity
`maximum`	`float`	0..1
`minimum`	`float`	0..1
`nominal`	`float`	0..1

3.2.8.1 `maximum`

The upper bound for the tool's process target feedrate.

3.2.8.2 `minimum`

The lower bound for the tools feedrate.

3.2.8.3 `nominal`

The nominal feedrate the tool is designed to operate at.

3.2.9 ProcessSpindleSpeed

The constrained process spindle speed for this tool.

Table 15: `Properties of ProcessSpindleSpeed`

Property	Type	Multiplicity
`maximum`	`float`	0..1
`minimum`	`float`	0..1
`nominal`	`float`	0..1

3.2.9.1 maximum

The upper bound for the tool's target spindle speed.

3.2.9.2 minimum

The lower bound for the tools spindle speed.

3.2.9.3 nominal

The nominal speed the tool is designed to operate at.

3.2.10 ReconditionCount

The number of times this cutter has been reconditioned.

Table 16: Properties of ReconditionCount

Property	Type	Multiplicity
maximumCount	integer	0..1

3.2.10.1 maximumCount

The maximum number of times this tool may be reconditioned.

3.2.11 Status

The status of the cutting tool.

Table 17: Properties of Status

Property	Type	Multiplicity
value	CutterStatusType	1

3.2.11.1 value

The status value of the cutting tool.

Enumeration for CutterStatus values.

Table 18: CutterStatusType Enumeration

Name	Description
NEW	A new tool that has not been used or first use. Marks the start of the tool history.
AVAILABLE	Indicates the tool is available for use. If this is not present, the tool is currently not ready to be used.
UNAVAILABLE	Indicates the tool is unavailable for use in metal removal. If this is not present, the tool is currently not ready to be used.
ALLOCATED	Indicates if this tool is has been committed to a piece of equipment for use and is not available for use in any other piece of equipment.
UNALLOCATED	Indicates this cutting tool has not been committed to a process and can be allocated.
MEASURED	The tool has been measured.
RECONDITIONED	The Cutting Tool has been reconditioned.
USED	The cutting tool is in process and has remaining tool life.
EXPIRED	The cutting tool has reached the end of its useful life.
BROKEN	Premature tool failure.
NOT_REGISTERED	This cutting tool cannot be used until it is entered into the system.
UNKNOWN	The cutting tool is an indeterminate state. This is the default value.

3.2.12 ToolLife

The cutting tool life as related to this assembly.

Table 19: `Properties of ToolLife`

Property	Type	Multiplicity
`countDirection`	`CountDirectionType`	1
`initial`	`float`	0..1
`limit`	`float`	0..1
`warning`	`float`	0..1

3.2.12.1 countDirection

Indicates if the tool life counts from zero to maximum or maximum to zero.

Enumeration for countDirection types.

Table 20: `CountDirectionType` Enumeration

Name	Description
`UP`	The tool life counts up from zero to the maximum.
`DOWN`	The tool life counts down from the maximum to zero.

3.2.12.2 initial

The initial life of the tool when it is new.

3.2.12.3 limit

The end of life limit for this tool.

3.2.12.4 warning

The point at which a tool life warning will be raised.

3.3 CuttingItemModel

3.3.1 CuttingItem

A CuttingItem is the portion of the tool that physically removes the material from the workpiece by shear deformation.

Table 21: `Properties of CuttingItem`

Property	Type	Multiplicity
`Description`	`string`	0..1
`grade`	`string`	0..1
`indices`	`string`	1
`itemId`	`ID`	0..1
`Locus`	`string`	0..1
`manufacturers`	`string`	0..1
`ProgramToolGroup`	`string`	0..1
`CutterStatus`	`Status`	1..*
`ItemLife`	`ItemLife`	0..1
`ItemLife`	`ItemLife`	0..1
`ItemLife`	`ItemLife`	0..1
`Measurements`	`Measurement`	0..*

3.3.1.1 `Description`

A free-form description of the Cutting Item.

3.3.1.2 `grade`

The material composition for this Cutting Item.

3.3.1.3 `indices`

The number or numbers representing the individual Cutting Item or items on the tool.

3.3.1.4 `itemId`

The manufacturer identifier of this Cutting Item.

3.3.1.5 Locus

A free form description of the location on the Cutting Tool.

3.3.1.6 manufacturers

The manufacturers of the Cutting Item or Tool.

3.3.1.7 ProgramToolGroup

The tool group this item is assigned in the part program.

3.3.1.8 CutterStatus

Placeholder for documentation!

3.3.1.9 ItemLife

Placeholder for documentation!

3.3.1.10 ItemLife

Placeholder for documentation!

3.3.1.11 ItemLife

Placeholder for documentation!

3.3.1.12 Measurements

Placeholder for documentation!

246 3.3.2 ItemLife

247 The life of this Cutting Item.

Table 22: `Properties of ItemLife`

Property	Type	Multiplicity
`countDirection`	`CountDirectionType`	1
`initial`	`float`	0..1
`limit`	`string`	0..1
`warning`	`float`	0..1

248 3.3.2.1 `countDirection`

249 Indicates if the item life counts from zero to maximum or maximum to zero.

250 Enumeration for countDirection types.

Table 23: `CountDirectionType` Enumeration

Name	Description
`UP`	The tool life counts up from zero to the maximum.
`DOWN`	The tool life counts down from the maximum to zero.

251 3.3.2.2 `initial`

252 The initial life of the item when it is new

253 3.3.2.3 `limit`

254 The end of life limit for this item.

255 3.3.2.4 `warning`

256 The point at which a item life warning will be raised.

Appendices

A Bibliography

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B Additional Illustrations

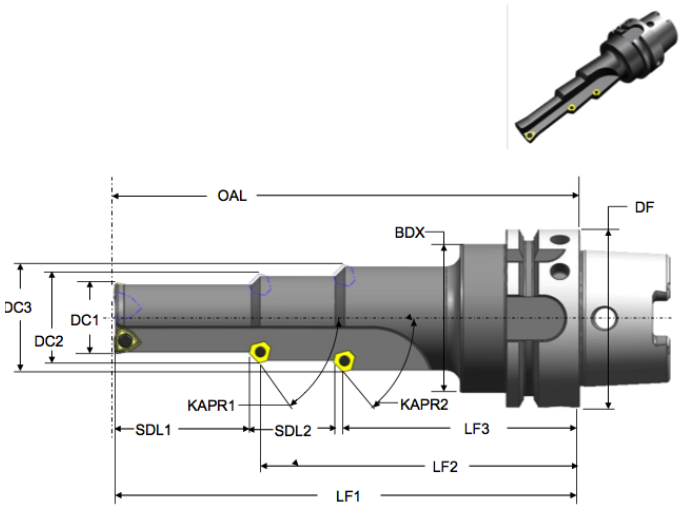


Figure 1: Cutting Tool Measurement Diagram 1
(Cutting Tool, Cutting Item, and Assembly Item – ISO 13399)

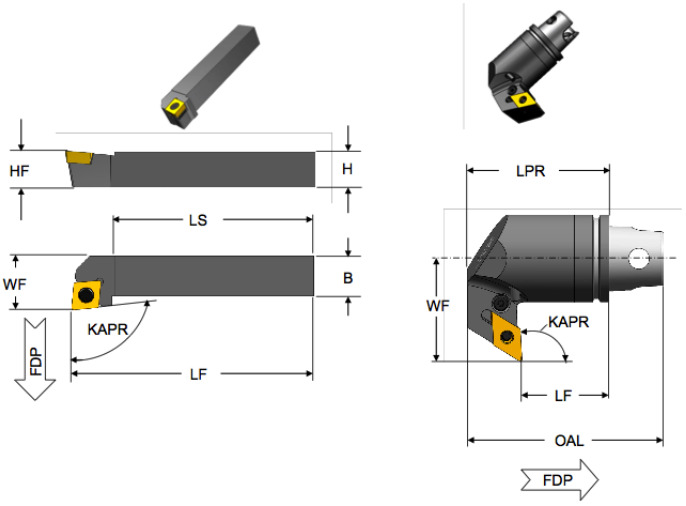


Figure 2: Cutting Tool Measurement Diagram 2
(Cutting Tool, Cutting Item, and Assembly Item – ISO 13399)

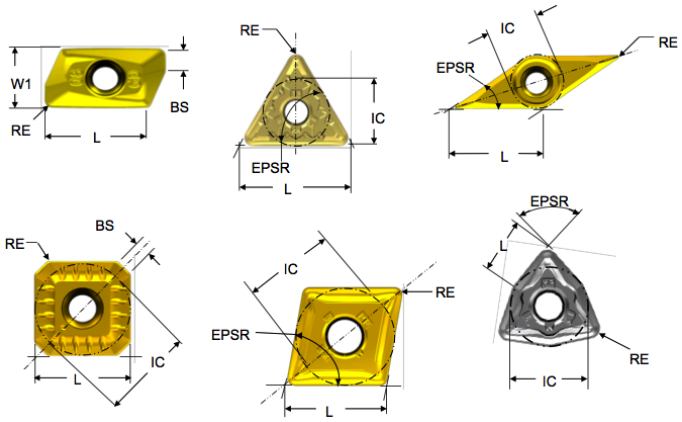


Figure 3: Cutting Tool Measurement Diagram 3
(Cutting Item – ISO 13399)

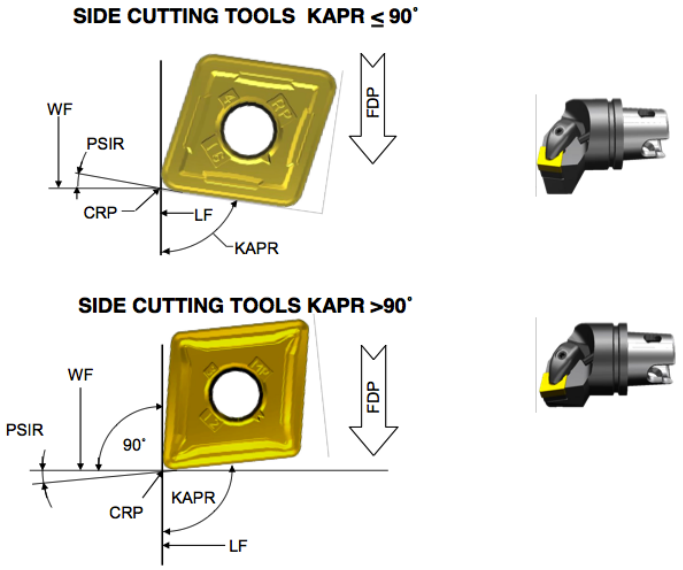


Figure 4: Cutting Tool Measurement Diagram 4
(Cutting Item – ISO 13399)

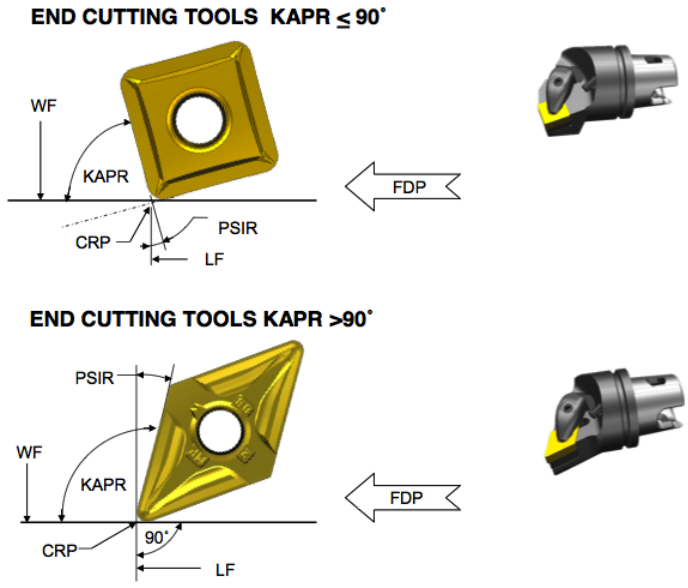


Figure 5: Cutting Tool Measurement Diagram 5
(Cutting Item – ISO 13399)

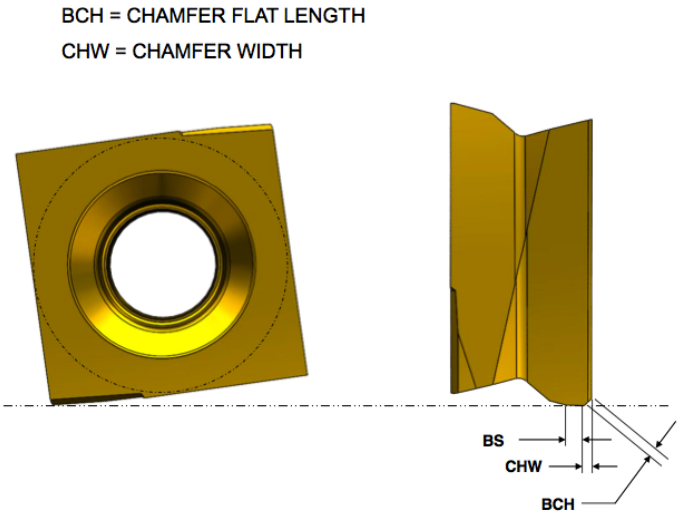


Figure 6: Cutting Tool Measurement Diagram 6
(Cutting Item – ISO 13399)

C Cutting Tool Example

C.1 Shell Mill

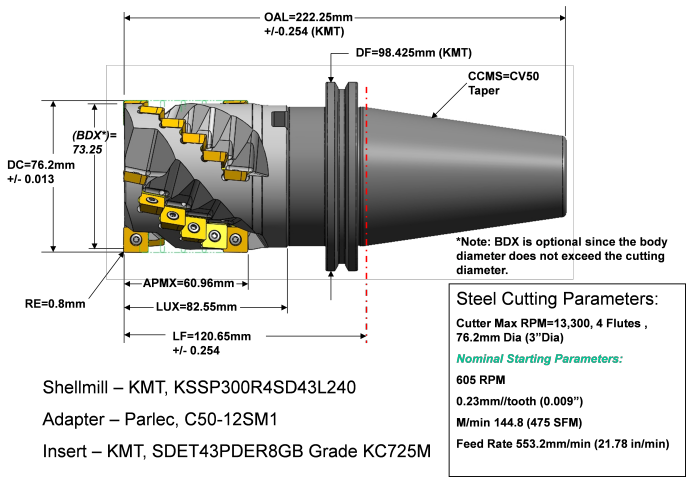


Figure 7: Shell Mill Side View

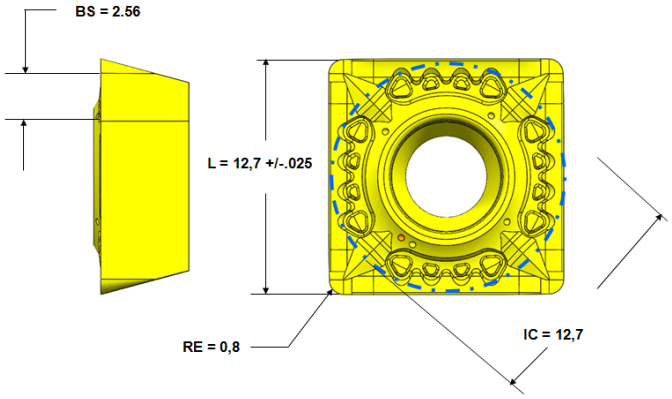


Figure 8: Indexable Insert Measurements

Example 1: Example for Indexable Insert Measurements

```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <MTConnectAssets
3 xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
4 xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
5 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
6 xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
7 http://mtconnect.org/schemas/MTConnectAssets\_1.2.xsd">
8   <Header creationTime="2011-05-11T13:55:22"
9   assetBufferSize="1024" sender="localhost"
```

```
312  10    assetCount="2" version="1.2" instanceId="1234"/>
313  11    <Assets>
314  12    <CuttingTool serialNumber="1" toolId="KSSP300R4SD43L240"
315  13    timestamp="2011-05-11T13:55:22" assetId="KSSP300R4SD43L240.1"
316  14    manufacturers="KMT,Parlec">
317  15      <CuttingToolLifeCycle>
318  16      <CutterStatus><Status>NEW</Status></CutterStatus>
319  17      <ProcessSpindleSpeed maximum="13300"
320  18      nominal="605">10000</ProcessSpindleSpeed>
321  19      <ProcessFeedRate
322  20      nominal="9.22">9.22</ProcessSpindleSpeed>
323  21      <ConnectionCodeMachineSide>CV50
324  22      </ConnectionCodeMachineSide>
325  23      <Measurements>
326  24        <BodyDiameterMax code="BDX">73.25
327  25        </BodyDiameterMax>
328  26        <OverallToolLength nominal="222.25"
329  27          minimum="221.996" maximum="222.504"
330  28          code="OAL">222.25</OverallToolLength>
331  29        <UsableLengthMax code="LUX" nominal="82.55">82.55
332  30        </UsableLengthMax>
333  31        <CuttingDiameterMax code="DC" nominal="76.2"
334  32          maximum="76.213" minimum="76.187">76.2
335  33        </CuttingDiameterMax>
336  34        <BodyLengthMax code="LF" nominal="120.65"
337  35          maximum="120.904" minimum="120.404">120.65
338  36        </BodyLengthMax>
339  37        <DepthOfCutMax code="APMX"
340  38        nominal="60.96">60.95</DepthOfCutMax>
341  39        <FlangeDiameterMax code="DF"
342  40          nominal="98.425">98.425</FlangeDiameterMax>
343  41      </Measurements>
344  42      <CuttingItems count="24">
345  43        <CuttingItem indices="1-24" itemId="SDET43PDER8GB"
346  44          manufacturers="KMT" grade="KC725M">
347  45          <Measurements>
348  46            <CuttingEdgeLength code="L" nominal="12.7"
349  47              minimum="12.675" maximum="12.725">12.7
350  48            </CuttingEdgeLength>
351  49          <WiperEdgeLength code="BS" nominal=
352  50            "2.56">2.56</WiperEdgeLength>
353  51          <IncribedCircleDiameter code="IC"
354  52            nominal="12.7">12.7
355  53          </IncribedCircleDiameter>
356  54          <CornerRadius code="RE" nominal="0.8">
357  55            0.8</CornerRadius>
358  56        </Measurements>
359  57        </CuttingItem>
360  58      </CuttingItems>
361  59      </CuttingToolLifeCycle>
362  60      </CuttingTool>
```

```
363  61    </Assets>
364  62  </MTConnectAssets>
```

C.2 Step Drill

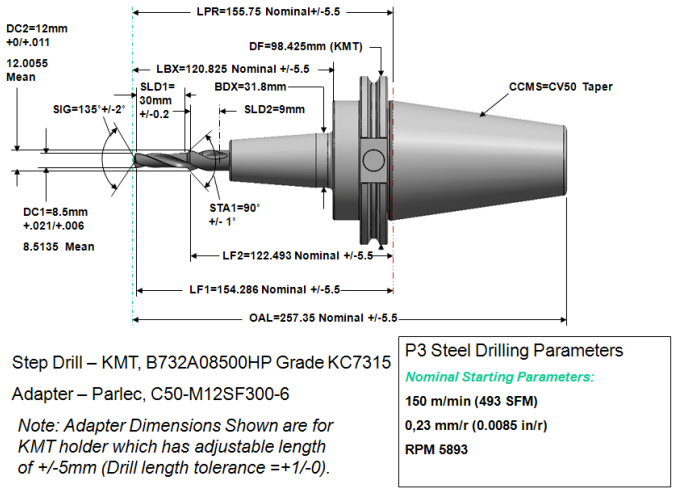


Figure 9: Step Mill Side View

Example 2: Example for Step Mill Side View

```
1  <?xml version="1.0" encoding="UTF-8"?>
2  <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
3  xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
4  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
5  xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
6  http://mtconnect.org/schemas/MTConnectAssets\_1.2.xsd">
7    <Header creationTime="2011-05-
8  ␣␣11T13:55:22" assetBufferSize="1024"
9    sender="localhost" assetCount="2" version="1.2" instanceId="1234"/>
10   <Assets>
11     <CuttingTool serialNumber="1␣" toolId="B732A08500HP"
12     timestamp="2011-05-11T13:55:22" assetId="B732A08500HP␣"
13     manufacturers="KMT,Parlec">
14       <Description>
15         Step Drill - KMT, B732A08500HP Grade KC7315
16         Adapter - Parlec, C50-M12SF300-6
17       </Description>
18       <CuttingToolLifeCycle>
19         <CutterStatus><Status>NEW</Status></CutterStatus>
20         <ProcessSpindleSpeed nominal="5893">5893</ProcessSpindleSpeed>
21         <ProcessFeedRate nominal="2.5">2.5</ProcessFeedRate>
22         <ConnectionCodeMachineSide>CV50 Taper</ConnectionCodeMachineSide>
23         <Measurements>
24           <BodyDiameterMax code="BDX">31.8</BodyDiameterMax>
25           <BodyLengthMax code="LBX" nominal="120.825" maximum="126.325"
26           minimum="115.325">120.825</BodyLengthMax>
27           <ProtrudingLength code="LPR" nominal="155.75" maximum="161.25"
28           minimum="150.26">155.75</ProtrudingLength>
```

```
394 29            <FlangeDiameterMax code="DF"
395 30            nominal="98.425">98.425</FlangeDiameterMax>
396 31            <OverallToolLength nominal="257.35" minimum="251.85"
397 32            maximum="262.85" code="OAL">257.35</OverallToolLength>
398 33          </Measurements>
399 34          <CuttingItems count="2">
400 35            <CuttingItem indices="1" manufacturers="KMT" grade="KC7315">>
401 36              <Measurements>
402 37                <CuttingDiameter code="DC1" nominal="8.5" maximum="8.521"
403 38                minimum="8.506">8.5135</CuttingDiameter>
404 39                <StepIncludedAngle code="STA1" nominal="90" maximum="91"
405 40                minimum="89">90</StepIncludedAngle>
406 41                <FunctionalLength code="LF1" nominal="154.286"
407 42                minimum="148.786"
408 43                maximum="159.786">154.286</FunctionalLength>
409 44                <StepDiameterLength code="SDL1"
410 45                nominal="9">9</StepDiameterLength>
411 46                <PointAngle code="SIG" nominal="135" minimum="133"
412 47                maximum="137">135</PointAngle>
413 48              </Measurements>
414 49            </CuttingItem>
415 50            <CuttingItem indices="2" manufacturers="KMT" grade="KC7315">>
416 51              <Measurements>
417 52                <CuttingDiameter code="DC2" nominal="12" maximum="12.011"
418 53                minimum="12">12</CuttingDiameter>
419 54                <FunctionalLength code="LF2" nominal="122.493"
420 55                maximum="127.993"
421 56                minimum="116.993">122.493</FunctionalLength>
422 57                <StepDiameterLength code="SDL2"
423 58                nominal="9">9</StepDiameterLength>
424 59              </Measurements>
425 60            </CuttingItem>
426 61          </CuttingItems>
427 62        </CuttingToolLifeCycle>
428 63      </CuttingTool>
429 64    </Assets>
430 65  </MTConnectAssets>
```

C.3 Shell Mill with Individual Loci

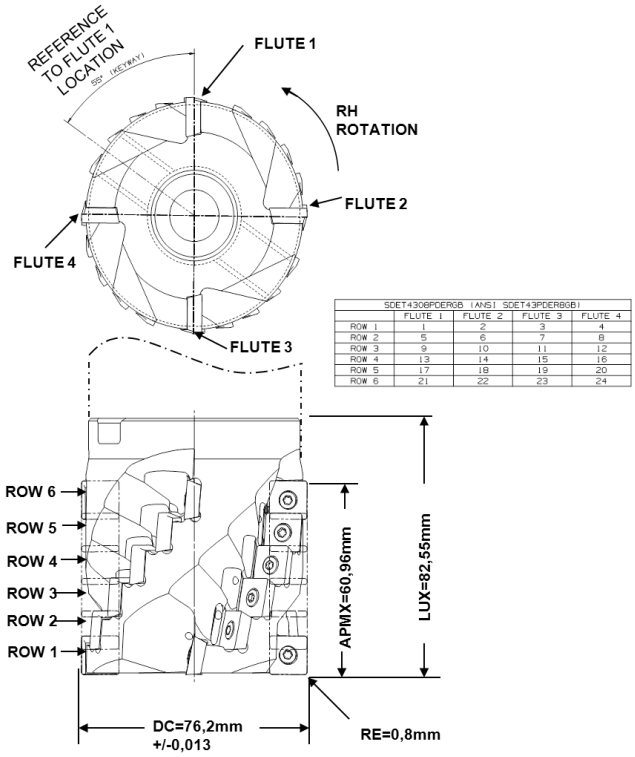


Figure 10: Shell Mill with Explicate Loci

Example 3: Example for Shell Mill with Explicate Loci

```
1  <?xml version="1.0" encoding="UTF-8"?>
2  <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
3  xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
4  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
5  xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
6  http://mtconnect.org/schemas/MTConnectAssets\_1.2.xsd">
7    <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
8    sender="localhost" assetCount="2" version="1.2" instanceId="1234"/>
9    <Assets>
10     <CuttingTool serialNumber="1" toolId="KSSP300R4SD43L240"
11     timestamp="2011-05-11T13:55:22" assetId="KSSP300R4SD43L240.1"
12     manufacturers="KMT,Parlec">
13       <Description>Keyway: 55 degrees</Description>
14       <CuttingToolLifeCycle>
15         <CutterStatus><Status>NEW</Status></CutterStatus>
16         <Measurements>
17           <UsableLengthMax code="LUX"
18           nominal="82.55">82.55</UsableLengthMax>
19           <CuttingDiameterMax code="DC" nominal="76.2" maximum="76.213"
```

```
451  20          minimum="76.187">76.2</CuttingDiameterMax>
452  21          <DepthOfCutMax code="APMX" nominal="60.96">60.95</DepthOfCutMax>
453  22        </Measurements>
454  23        <CuttingItems count="24">
455  24          <CuttingItem indices="1" itemId="SDET43PDER8GB"
456  25          manufacturers="KMT">
457  26            <Locus>FLUTE: 1, ROW: 1</Locus>
458  27            <Measurements>
459  28             <DriveAngle code="DRVA" nominal="55">55</DriveAngle>
460  29           </Measurements>
461  30          </CuttingItem>
462  31          <CuttingItem indices="2-24" itemId="SDET43PDER8GB"
463  32          manufacturers="KMT">
464  33            <Locus>FLUTE: 2-4, ROW: 1; FLUTE: 1-4, ROW 2-6</Locus>
465  34          </CuttingItem>
466  35        </CuttingItems>
467  36      </CuttingToolLifeCycle>
468  37    </CuttingTool>
469  38  </Assets>
470  39 </MTConnectAssets>
```

C.4 Drill with Individual Loci

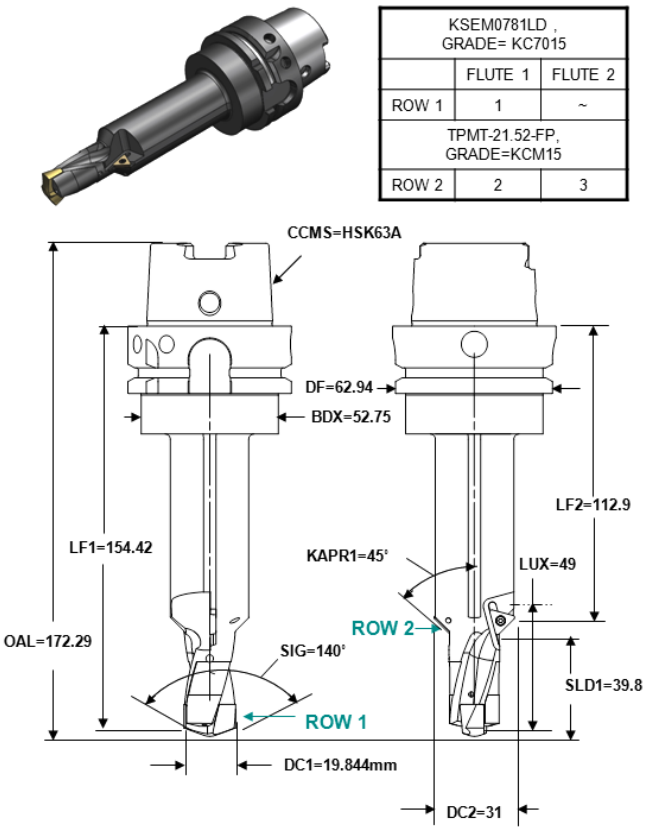


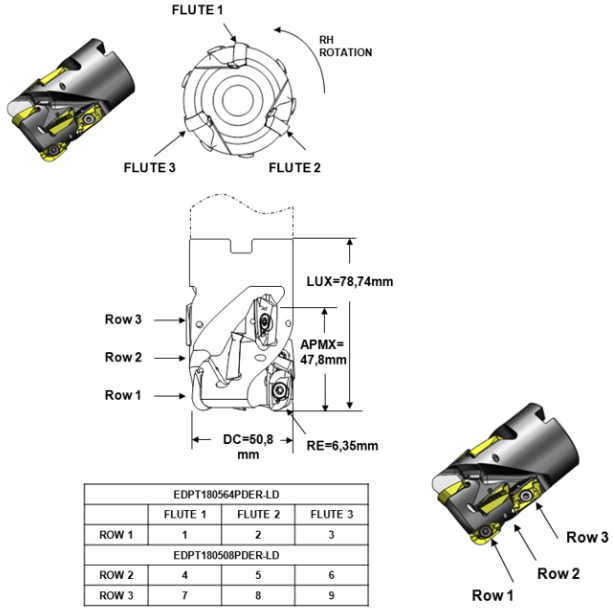
Figure 11: Step Drill with Explicate Loci

Example 4: Example for Step Drill with Explicate Loci

```
1  <?xml version="1.0" encoding="UTF-8"?>
2  <MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
3  xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
4  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
5  xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
6  http://mtconnect.org/schemas/MTConnectAssets\_1.2.xsd">
7    <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
8    sender="localhost" assetCount="2" version="1.2" instanceId="1234"/>
9    <Assets>
10     <CuttingTool serialNumber="1" toolId="KSEM0781LD"
11     timestamp="2011-05-11T13:55:22" assetId="KSEM0781LD.1" manufacturers="KMT">
12       <CuttingToolLifeCycle>
13         <CutterStatus><Status>NEW</Status></CutterStatus>
14         <ConnectionCodeMachineSide>HSK63A</ConnectionCodeMachineSide>
15         <Measurements>
16           <BodyDiameterMax code="BDX">52.75</BodyDiameterMax>
17           <OverallToolLength nominal="172.29"
```

```
489 18            code="OAL">172.29</OverallToolLength>
490 19            <UsableLengthMax code="LUX" nominal="49">49</UsableLengthMax>
491 20            <FlangeDiameterMax code="DF"
492 21            nominal="62.94">62.94</FlangeDiameterMax>
493 22          </Measurements>
494 23          <CuttingItems count="3">
495 24            <CuttingItem indices="1" itemId="KSEM0781LD" manufacturers="KMT"
496 25            grade="KC7015">
497 26              <Locus>FLUTE: 1, ROW: 1</Locus>
498 27              <Measurements>
499 28           <FunctionalLength code="LF1" nominal="154.42">154.42</FunctionalLength>
500 29           <CuttingDiameter code="DC1" nominal="19.844">19.844</CuttingDiameter>
501 30           <PointAngle code="SIG" nominal="140">140</PointAngle>
502 31           <ToolCuttingEdgeAngle code="KAPR1" nominal="45">45</ToolCuttingEdgeAngle>
503 32           <StepDiameterLength code="SLD1" nominal="39.8">39.8</StepDiameterLength>
504 33              </Measurements>
505 34            </CuttingItem>
506 35            <CuttingItem indices="2-3" itemId="TPMT-21.52-FP"
507 36            manufacturers="KMT" grade="KCM15">
508 37              <Locus>FLUTE: 1-2, ROW: 2</Locus>
509 38              <Measurements>
510 39           <FunctionalLength code="LF2" nominal="112.9">119.2</FunctionalLength>
511 40           <CuttingDiameter code="DC2" nominal="31">31</CuttingDiameter>
512 41              </Measurements>
513 42            </CuttingItem>
514 43          </CuttingItems>
515 44        </CuttingToolLifeCycle>
516 45      </CuttingTool>
517 46    </Assets>
518 47  </MTConnectAssets>
```

C.5 Shell Mill with Different Inserts on First Row



EDPT180564PDER-LD			
	FLUTE 1	FLUTE 2	FLUTE 3
ROW 1	1	2	3
EDPT180508PDER-LD			
ROW 2	4	5	6
ROW 3	7	8	9

Figure 12: Shell Mill with Different Inserts on First Row

Example 5: Example for Shell Mill with Different Inserts on First Row

```
<?xml version="1.0" encoding="UTF-8"?>
<MTConnectAssets xmlns:m="urn:mtconnect.org:MTConnectAssets:1.2"
xmlns="urn:mtconnect.org:MTConnectAssets:1.2"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="urn:mtconnect.org:MTConnectAssets:1.2
http://mtconnect.org/schemas/MTConnectAssets\_1.2.xsd">
  <Header creationTime="2011-05-11T13:55:22" assetBufferSize="1024"
  sender="localhost" assetCount="2" version="1.2" instanceId="1234"/>
  <Assets>
    <CuttingTool serialNumber="1" toolId="XXX" timestamp="2011-05-11T13:55:22"
    assetId="XXX.1" manufacturers="KMT">
      <CuttingToolLifeCycle>
        <CutterStatus><Status>NEW</Status></CutterStatus>
        <Measurements>
          <DepthOfCutMax code="APMX" nominal="47.8">47.8</DepthOfCutMax>
          <CuttingDiameterMax code="DC"
          nominal="50.8">50.8</CuttingDiameterMax>
          <UsableLengthMax code="LUX"
          nominal="78.74">78.74</UsableLengthMax>
        </Measurements>
        <CuttingItems count="9">
          <CuttingItem indices="1-3" itemId="EDPT180564PDER-LD"
          manufacturers="KMT">
            <Locus>FLUTE: 1-3, ROW: 1</Locus>
```

```
544 25              <Measurements>
545 26                <CornerRadius code="RE" nominal="6.25">6.35</CornerRadius>
546 27              </Measurements>
547 28            </CuttingItem>
548 29            <CuttingItem indices="4-9" itemId="EDPT180508PDER-LD"
549 30            manufacturers="KMT">
550 31              <Locus>FLANGE: 1-4, ROW: 2-3</Locus>
551 32            </CuttingItem>
552 33          </CuttingItems>
553 34        </CuttingToolLifeCycle>
554 35      </CuttingTool>
555 36    </Assets>
556 37  </MTConnectAssets>
```